2010-09

Implementation challenges for DoD logistics Enterprise Resource Planning IT systems

Jones, Mark W.

Monterey, California. Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

IMPLEMENTATION CHALLENGES FOR DOD LOGISTICS ENTERPRISE RESOURCE PLANNING IT SYSTEMS

by

Mark W. Jones

September 2010

Thesis Co-Advisors: Charles Pickar
Mark M. Rhoades

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** September 2010	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE Implementation Challenges for DoD Logistics Enterprise Resource Planning IT Systems		**5. FUNDING NUMBERS**	
6. AUTHOR(S) Mark W. Jones			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		**8. PERFORMING ORGANIZATION REPORT NUMBER**	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**	
11. SUPPLEMENTARY NOTES N/A			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		**12b. DISTRIBUTION CODE**	

13. ABSTRACT (maximum 200 words)

In the summer of 2008, the Global Combat Support System—Marine Corps (GCSS-MC) breached both cost and schedule in development of their ERP system. In addition, Navy ERP has had problems, GCSS-Army has been delayed, and the Air Force Expeditionary Combat Support System (ECSS) is currently rebaselining their program. Why are all of these DoD ERP system development efforts having difficulty and is there a better way to implement ERP systems in the DoD?

This research focuses on DoD ERP implementation efforts ongoing in the Army, Navy, Air Force, and Marine Corps. A macro-level review of six DoD ERP implementations provides a historical perspective reflecting the difficulty all have had in developing their respective ERP systems. A micro-level review of the GCSS-MC program identifies systems engineering challenges the program has faced. The conclusion is that all Service Components have similar requirements and all struggle with development of their respective ERP solution. Much money has been and continues to be spent on ERP implementation and each implementation has taken much more time than was originally planned. It is important for the DoD to take a hard look at how the current ERP solutions have been developed and determine alternate ways to develop similar systems in the future. The DoD cannot afford the billions of dollars that have been spent on multiple system developments and needs to figure out a way to consolidate efforts between the Service Components. These consolidated efforts may provide not only an expedited system development effort but also a common system that can be centrally managed and used to breakdown the unique stove pipe processes within each Service and transform logistics chain management as it is known today.

14. SUBJECT TERMS Logistics, ERP, Enterprise Resource Planning,			**15. NUMBER OF PAGES** 111
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

IMPLEMENTATION CHALLENGES FOR DOD LOGISTICS ENTERPRISE RESOURCE PLANNING IT SYSTEMS

Mark W. Jones
YF-3, United States Marine Corps
B.S.E.E., University of Akron, 1985

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS ENGINEERING MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 2010

Author: Mark W. Jones

Approved by: Charles K. Pickar, DBA
Thesis Co-Advisor

Mark M. Rhoades
Thesis Co-Advisor

Clifford Whitcomb, Ph.D.
Chairman, Department of Systems Engineering

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

In the summer of 2008, the Global Combat Support System—Marine Corps (GCSS-MC) breached both cost and schedule in development of their ERP system. In addition, Navy ERP has had problems, GCSS-Army has been delayed, and the Air Force Expeditionary Combat Support System (ECSS) is currently rebaselining their program. Why are all of these DoD ERP system development efforts having difficulty and is there a better way to implement ERP systems in the DoD?

This research focuses on DoD ERP implementation efforts ongoing in the Army, Navy, Air Force, and Marine Corps. A macro-level review of six DoD ERP implementations provides a historical perspective reflecting the difficulty all have had in developing their respective ERP systems. A micro-level review of the GCSS-MC program identifies systems engineering challenges the program has faced. The conclusion is that all Service Components have similar requirements and all struggle with development of their respective ERP solution. Much money has been and continues to be spent on ERP implementation and each implementation has taken much more time than was originally planned. It is important for the DoD to take a hard look at how the current ERP solutions have been developed and determine alternate ways to develop similar systems in the future. The DoD cannot afford the billions of dollars that have been spent on multiple system developments and needs to figure out a way to consolidate efforts between the Service Components. These consolidated efforts may provide not only an expedited system development effort but also a common system that can be centrally managed and used to breakdown the unique stove pipe processes within each Service and transform logistics chain management as it is known today.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ABBREVIATIONS AND ACRONYMS

AIM	Application Implementation Methodology
AIT	Automated Identification Technology
AS/AP	Acquisition Strategy / Acquisition Plan
CARD	Cost Analysis Requirements Description
CCT	Critical Change Team
CDD	Capability Development Document
COBOL	Common Business-Oriented Language
CONOPS	Concept of Operations
COTS	Commercial-Off-The-Shelf
CSS	Combat Service Support
DEAMS	Defense Enterprise Accounting and Management System
DoD	Department of Defense
DRR	Design Readiness Review
EA	Enterprise Architecture
ECSS	Expeditionary Combat Support System
eLog21	Expeditionary Logistics for the 21st century
ERP	Enterprise Resource Planning
FOC	Full Operational Capability
FRP	Full Rate Production
FUE	Field User Evaluation
GAO	General Accounting Office
GCSS-A	Global Combat Support System - Army
GCSS-MC	Global Combat Support Services - Marine Corps
I	Intermediate
IA	Information Assurance
ICP	Inventory Control Point
ICD	Initial Capabilities Document
IT	Information Technology
JDA	Joint Data Element
JFMIP	Joint Financial Management Improvement Program

JTA	Joint Technical Architecture
KPP	Key Performance Parameter
LCM	Logistics Chain Management
LMP	Logistics Modernization Program
MA	Mission Area
MAGTF	Marine Air Ground Task Force
MAIS	Major Automated Information Systems
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MNS	Mission Need Statement
MQR	MAIS Quarterly Report
MS	Milestone
MTMC	Military Traffic Management Command
NR	Net Ready
OA	Operational Analysis
ORD	Operational Requirements Document
OV	Operational View
RFA	Resource Financial Accounting
RFID	Radio Frequency Identification
RICE	Reports, Interfaces, Conversions, Extensions
PDSS	Post Deployment Software Support
SASSY	Supported Activity Supply System
SCOR	Supply Chain Operations Reference
SE	Systems Engineering
SEP	System Engineering Plan
SFIS	Standard Financial Information Structure
SSA	Supply Support Activity
SSS	System Subsystem Specification
TAV	Total Asset Visibility
U.S.	United States
WWW	World Wide Web

EXECUTIVE SUMMARY

On August 7, 1990, the deployment of United States (U.S.) forces begun under Operation DESERT SHIELD [1]. Iraq's invasion of Kuwait triggered the largest rapid deployment of U.S. forces and supplies in history for the planning and movement of troops, equipment, and supplies as required by Operation Desert Shield/Storm [2]. Such a significant movement of resources to support combat operations requires the use of Information Technology (IT) systems to track and manage the logistics chain for all supplies and scheduling of maintenance within the theater of operation.

The use of ERP systems in the DoD is becoming the method of choice to develop small increments of capability rapidly. The old method of developing a large amount of capability in one increment is too costly, takes too long, and may possibly result in implementing out-dated technology by the time the software is released for use. An ERP system can be developed one business application at a time and provide a foundation for all other business applications to be added later.

Each Service Component of the DoD is essentially trying to accomplish the same goal in modernizing their aging logistics IT systems. Functionally, each Service Component is developing redundant capability. Development of logistics ERP systems in the DoD have been plagued by cost overruns and schedule delays in the Army, Air Force, Navy, and Marine Corps. All Services have experienced similar program management and system engineering challenges recognized by the GAO and continue to struggle with development of their ERP systems. With the GAO identifying several weaknesses in each independent ERP development and with the common technical challenges evident across the DoD, would it make sense to develop only one ERP system for use across all Service Components instead of developing multiple independent Service unique ERP systems?

This thesis analyzes six of the logistics ERP efforts currently ongoing in the DoD and provides an analysis to support the development of a single integrated ERP system to be used by all four Services.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

I would like to thank the Marine Corps Systems Command and Dr. John Burrow for providing me the opportunity to expand my knowledge in the area of Systems Engineering and to obtain a Master's degree in Systems Engineering Management. I would like to thank the Department of the Navy Research, Development and Acquisition - Chief Systems Engineer for providing the funding for this Masters program. Thank you to the GCSS-MC Program Office and Mr. Dan Corbin and Mr. Pete Sandlin for understanding and providing me the time to complete the program course work. Thank you to the GCSS-MC technical team of Travis Hubbard, Sandra Smith, Rich Davis, and Jason Hackerson for their time in helping me formulate my thoughts and ideas, your support is very much appreciated.

Thank you to the Naval Postgraduate School, my Thesis advisors Dr. Charles Pickar and Professor Mark Rhoades for their wisdom and guidance in helping me development, write, and refine this thesis, and to Mr. Wally Owen for his support and guidance.

Thank you to PD21 SEM Cohort 9. Charlotte, Mytiec, Jason, Ellen, Derek, Dan, Mariela, Steve, Les, and Mike, your support was incredible over the last two years and I am truly appreciative of your willingness to work as a team and for your encouragement to help get me over the finish line. I know I have made friends for life and I look forward to working with you again at some point in the future.

Thank you to my family, Trey and Sagan, for encouraging their father to follow in their footsteps to work hard, stay in school, and graduate. Finally, thank you very much to my partner in life of 27 years, my loving wife, Barbara, for her patience, understanding, and encouragement over the last two years. Your support has meant so much to me; I cannot thank you enough (although that to-do list I will start working on after graduation will be a good start).

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

On August 2, 1990, the Iraqi Republican Guard invaded Kuwait and seized control of that country. On August 7, the deployment of United States (U.S.) forces that became known as Operation DESERT SHIELD began [1]. Iraq's invasion of Kuwait triggered the largest rapid deployment of U.S. forces and supplies in history for the planning and movement of troops, equipment, and supplies as required by Operation Desert Shield/Storm [2]. By 1 February 1991, less than 6 months into deployment, the Transportation Command had moved about 440,000 passengers, 3 million tons of unit equipment and supplies, and 4.2 million tons of fuel supplies to Southwest Asia in preparation for offensive action against Iraq [2].

In 2002, the United States and the United Kingdom claimed Iraq possessed weapons of mass destruction and posed a threat to their security and that of their allies and Operation Iraqi Freedom (OIF) began on March 20, 2003 [3]. Between 1 April 2003 and June 2003, the Military Traffic Management Command (MTMC)[1] delivered 42.2 million meals to Iraq, loaded cargo covering 15 million square feet, transported 1.5 million tons of equipment and cargo, and moved 98,890 containers [4]. Logistics support during OIF was not very timely. The logistics system "pull" processes depended on line-of-sight communications that broke down due to lack of connectivity required to assure fulfillment of end-user materiel requests. This problem was resolved by emphasizing a "push" system that pushed materiel forward without waiting for a request. While the ability to identify what containers arriving in theater were carrying was clearly and generally much better than a decade earlier in Operation Desert Storm, asset visibility after in-theater distribution declined dramatically, probably due in part to the emphasis on pushing materiel forward [5].

[1] MTMC is a Major Army Command (MACOM) that is the overland lift component and primary traffic manager for USTRANSCOM [6].

The significant movement of resources to support combat operations required the use of Information Technology (IT) systems to track and manage the logistics chain for all supplies and scheduling of maintenance within the theater of operation. Desert Shield, Desert Storm, and Operation Iraqi Freedom proved to be key events in providing valuable lessons learned in how well the United States military IT systems supported logistics chain management. During combat operations, the Marine Corps IT ground logistics systems did not communicate well, were not integrated, ran very slowly with significant lag times, and provided uncertain or unreliable data. The inefficiencies and inaccuracies of the IT systems resulted in multiple supplies being ordered with the inability to accurately track and distribute the supplies. Something had to be done to modernize the Marine Corps ground-based logistics IT systems; thus, the Global Combat Support System (GCSS-MC) program was initiated [7].

The GCSS-MC IT system is being designed to modernize the Marine Corps Logistics IT capability. It is intended to provide the capabilities to execute Marine Air Ground Task Force (MAGTF) Combat Service Support (CSS) in expeditionary and joint environments. It will improve logistics chain management effectiveness and efficiency and will provide actionable combat support information to leadership. Existing Marine Corps IT logistics systems are numerous and many are over 30 years old. Support for these antiquated systems is disappearing. Several of the Marine Corps ground based logistics systems were developed using the Common Business-Oriented Language (COBOL) programming language developed in 1959 [8]. One example is the Supported Activity Supply System (SASSY). It is a mainframe system developed in the 1970s using the COBOL programming language; it is still in use today. SASSY is hard to use, contains inaccurate data, and does not efficiently support the war fighter [9]. It is becoming increasingly difficult to support as the software requires much patching and the COBOL SASSY programmers are becoming harder to find and maintain in the work force. The new GCSS-MC system is being built using the Commercial-Off-The-Shelf (COTS) Oracle 11i E-Business Suite. This is an Enterprise Resource Planning (ERP) software that will not only address the immediate need of an integrated supply and

maintenance system, but will be the foundation for the integration and replacement of other Marine Corps logistics systems that currently provide warehouse, transportation, and many other logistics functionality.

Operationally, the GCSS-MC software will allow Marines to accurately capture data within a shared data environment via a secure connection using the World Wide Web (WWW). It will allow the use of Automated Identification Technology (AIT) devices, such as hand held scanners and passive and active Radio Frequency Identification (RFID) scanners, to input data into a centralized shared data environment. Users who are in geographic regions with good Internet connectivity will have direct access to the shared data environment. Users who are deployed in remote, austere environments will have a local instance of GCSS-MC that will be able to communicate back to the centralized shared data environment when communications are up and operational [7]. The Operational View (OV), OV-1, is shown in Figure 1 [10]. Figure 2 shows the flow of information from the Enterprise Server located in the continental United States to the forward deployed units in an austere environment [11].

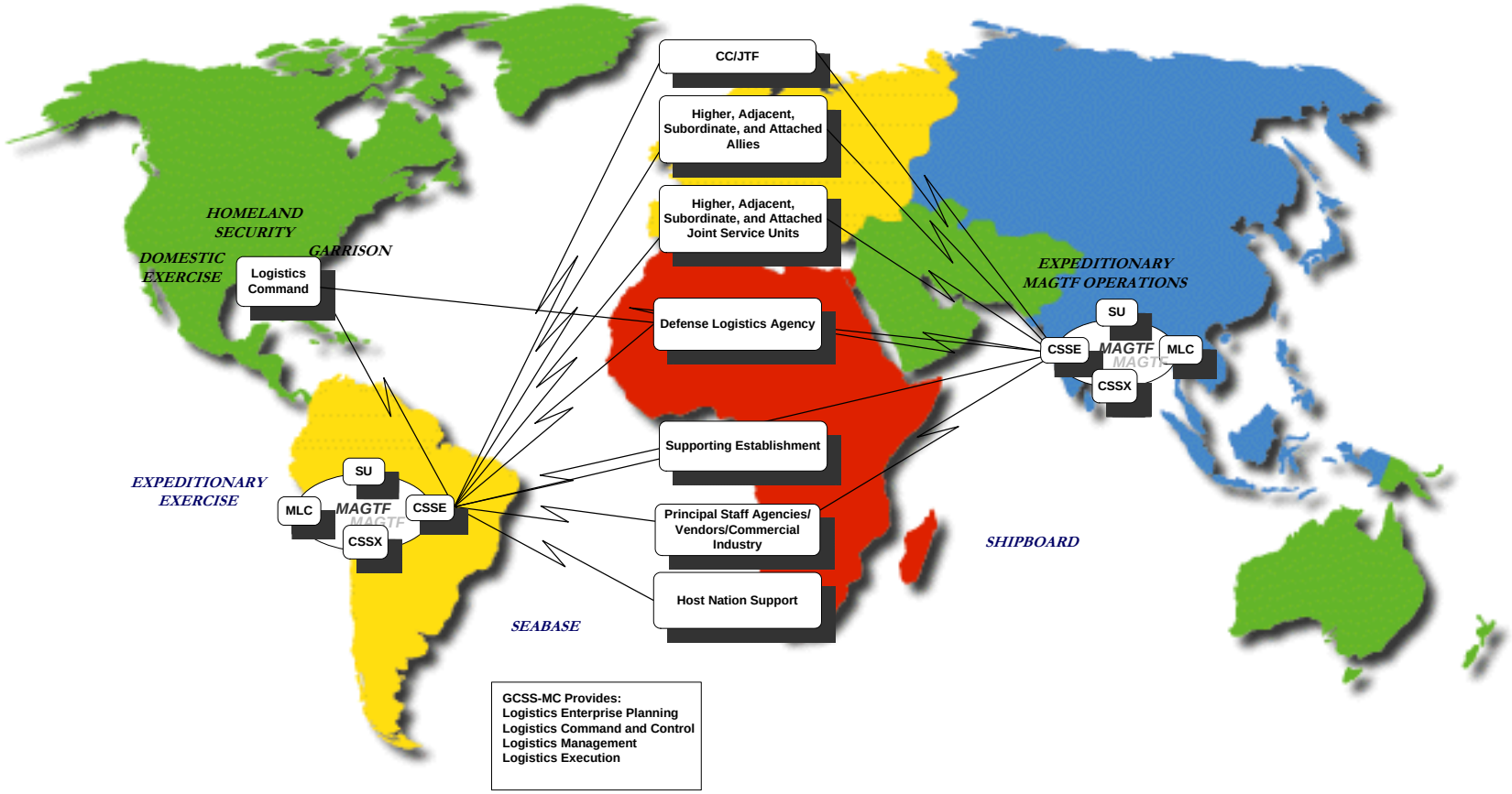

Figure 1. GCSS-MC OV-1. From [10]

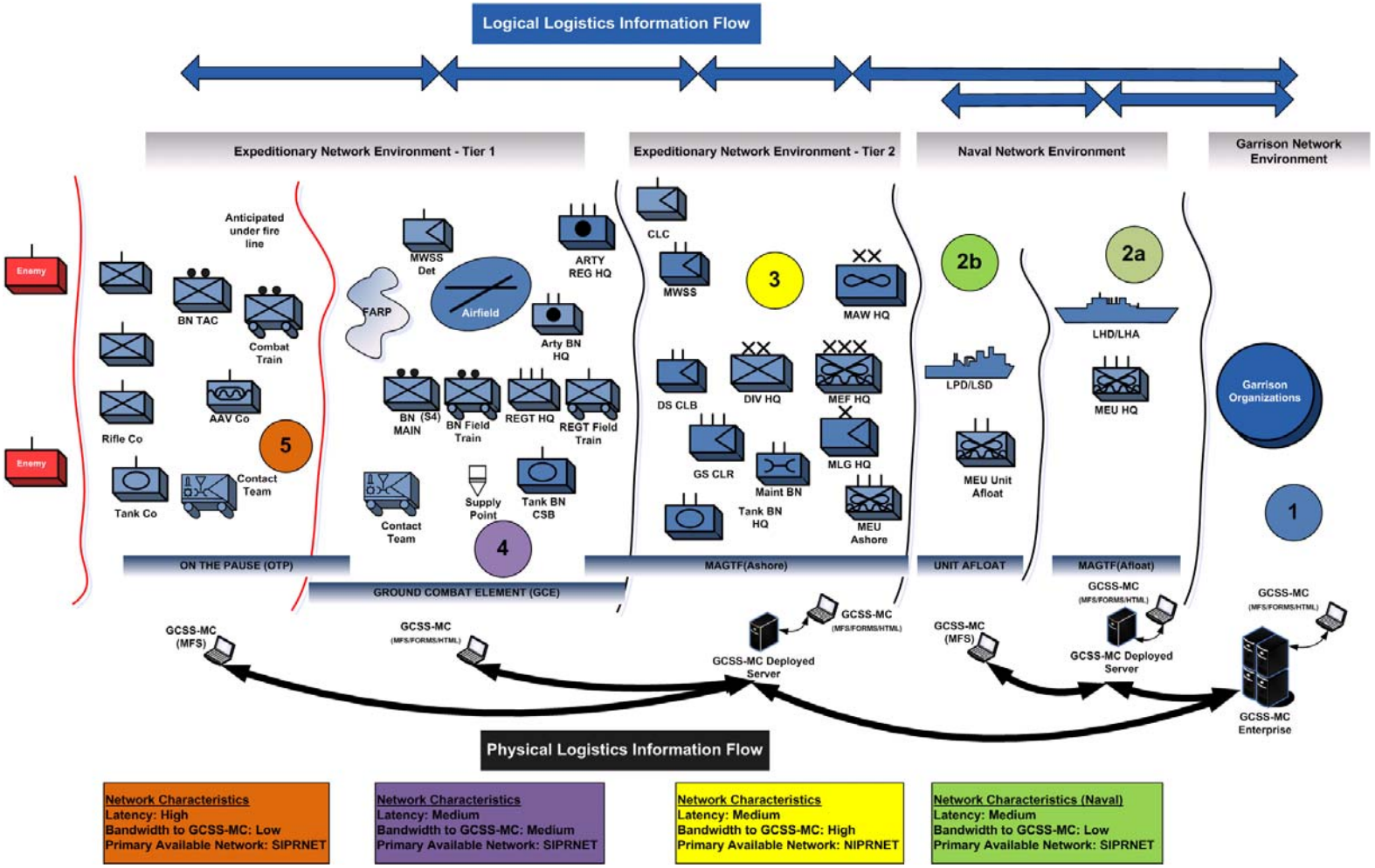

Figure 2. GCSS-MC Operational Environments. From [11]

B. PURPOSE

The use of ERP systems in the DoD is becoming the method of choice to develop small increments of capability rapidly. The old method of developing a large amount of capability in one increment is too costly, takes too long, and may possibly result in implementing out-dated technology by the time the software is released for use. An ERP system can be developed one business application at a time and provide a foundation for all other business applications to be added later. According to Parr and Shanks [12], an ERP may be implemented in one of three ways. The ERP may be implemented in its entirety, but it is very complex and can take up to seven years to implement. The ERP may be implemented using only a core module without any business process reengineering; it is relatively inexpensive but may not provide all of the needed functionality. Alternatively, the ERP may be implemented using only a selection of its core ERP modules along with significant business process reengineering. This methodology is exactly what the Marine Corps decided to do, implement the supply and maintenance management capability of the Oracle E-Business ERP in one small increment and defer the development of other business areas such as Warehousing, Transportation, Planning, Finance, Human Resources, and Engineering to other increments. In particular, the Marine Corps has decided to develop capabilities to address immediate ground based logistics chain management shortfalls as defined by the requirements in the GCSS-MC Capability Development Document [13]. The purpose of this thesis is to investigate the ERP development efforts in DoD, understand what makes implementation of these development efforts so difficult, and provide a recommendation as to an alternate way to develop and implement a single ERP system across all of the DoD.

C. RESEARCH QUESTIONS

The DoD has selected two main suites of software for their logistics modernization ERP efforts. The Army and Navy have selected SAP and the Air Force and Marine Corps have selected the Oracle E-Business Suite. Both ERP solutions allow the incremental development of capability within the software suite. In the case of

GCSS-MC, the Oracle product was best suited to satisfy both the functional and technical capabilities as described the GCSS-MC CDD [14]. The Marine Corps' initial focus is only on the supply and maintenance management functionality. By first addressing this limited functionality, the Program Office increased potential success of meeting schedule timelines within budget. However, since the inception of the GCSS-MC program, the development effort has still been prone to cost and schedule overruns [15].

The following questions will be analyzed:

- What are the DoD ERP IT system implementation challenges in the Army, Air Force, Navy, and Marine Corps?
- What are the GCSS-MC system engineering technical and functional challenges with regards to the design and build of the GCSS-MC system?

D. BENEFITS OF STUDY

Development of ERP systems in the DoD have been plagued by cost overruns and schedule delays in the Army, Air Force, Navy, and Marine Corps as documented in several GAO reports [15, 16, 17, 18]. This thesis will review and analyze the ERP development efforts of those services at a high level as well as review and analyze details of the GCSS-MC program development effort. Implementation challenges will be identified to highlight the difficulties that DoD ERP programs experience and will serve as data for a recommendation of how to implement future DoD ERP developments.

E. SCOPE AND METHODOLOGY

The scope for this research focuses on DoD ERP implementation efforts ongoing in the Army, Navy, Air Force, and Marine Corps. A macro review of six DoD ERP implementations provides a historical perspective reflecting the difficulty all have had in developing their respective ERP systems. A micro review of the GCSS-MC program provides some of the detailed systems engineering challenges the program has faced. The methodology, shown in Figure 3, consists of performing two main steps resulting in a collection of DoD ERP implementation challenges.

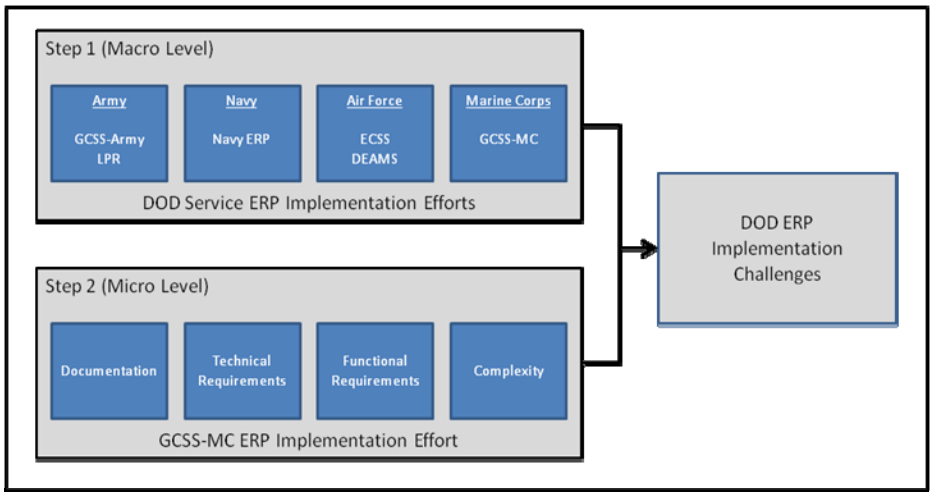

Figure 3. Methodology

1. Review of DoD Service ERP Implementation Efforts

The Army is developing GCSS-Army and the Logistics Modernization Program (LMP), the Air Force is developing Expeditionary Combat Support System (ECSS) and Defense Enterprise Accounting and Management System (DEAMS), the Navy is developing Navy ERP, and the Marine Corps is developing GCSS-MC. Each service has had difficulties in developing their ERP system. This thesis examines each service's difficulties at a macro level and identifies challenges in DoD ERP developments in general.

2. Review of the GCSS-MC ERP Implementation Effort

This thesis reviews GCSS-MC technical and functional requirements and provides a basis for the amount and scope of capability that the Marine Corps is trying to develop. The GCSS-MC requirements are very unique than those in the private sector. The nature of the Marine Corps to deploy troops on the move in austere environments is very different than the private sector's stationary brick buildings and warehouses. It is the uniqueness of those requirements and the complexity behind the implementation of those requirements that cause much of the program's cost overruns and schedule delays. The GCSS-MC requirements are analyzed for technical complexity and scope of effort.

F. CHAPTER SUMMARY

This chapter introduces the Marine Corps challenges in management of USMC logistics chain management using IT systems that are more than 30 years. The use of these IT systems during Desert Shield, Desert Storm, and Operation Iraqi Freedom proved that these antiquated systems, while effective for immediate war time situations, could actually be more efficient and beneficial to the war fighter if redesigned using a distributed, integrated IT system. Modernization of logistics chain management IT systems provides a more reliable and accurate logistics management capability that the war fighter desperately needs.

Answers to research questions require analysis of ERP system implementations currently within the DoD to understand the system engineering, technical, and functional challenges that cause program cost overruns and schedule delays. Analysis of GCSS-MC system engineering requirements development identifies challenges that should be avoided by the DoD in the development of future ERP systems.

Chapter II provides a collection of Army, Navy, Air Force, and Marine Corps ERP implementation information in terms of GAO findings, functionality, cost, and schedule. This comparison serves as the foundation to illustrate the difficulties that these DoD services have had in implementing ERP systems.

Chapter III provides a review of the GCSS-MC ERP implementation effort. The program's systems engineering challenges are identified in the areas of requirements development and COTS customization. Functional and technical requirements are analyzed with respect to complexity and the amount of customization required to the COTS software to provide the required Marine Corps business process functionality.

Chapter IV analyzes at a high level the implementation challenges of all service ERP efforts as well as the GCSS-MC systems engineering challenges. All of which serve as potential indicators supporting a recommendation of developing a single ERP system to be used by all Service Components.

Chapter V provides conclusions and makes a recommendation as to how DoD should develop a single ERP system implemented across all Services. It also makes recommendations as to areas to conduct further research.

II. DOD ERP IMPLEMENTATION CHALLENGES

A. INTRODUCTION

The Department of Defense set a goal over 30 years ago to obtain total asset visibility (TAV). Per a GAO report [19], the DoD planned to have the total asset visibility capability achieved by 2004 and as of July 2007 was still unsuccessful [16]. DoD's new target date to achieve TAV is now 2010 [19]. To meet the TAV goal, the Department of Defense has taken on the development of several ERP implementations all providing a wide array of capability unique to each service. Each service's implementation is designed to modernize business systems mainly focusing on logistics management of assets and financial tracking of those assets. All use ERP software from either Oracle or SAP, but each with different levels of scope and functionality designed to replace existing legacy logistics IT systems. Many of these legacy systems have been in service for over 30 years and support for these systems is becoming scarce. While these systems may be relatively inexpensive to maintain as individual systems, the price is high in terms of data being stove piped, inaccurate, or not accessible in a timely manner. Research and analysis of current legacy systems and the reason for replacing them is discussed further in Chapter IV.

Since 1995, the GAO designated DoD's business systems modernization as high risk [18]. The GAO points out that there are many challenges involved with DoD ERP implementation. Programs are not aligned to a DoD business enterprise architecture that is not fully defined. Program management is weak in the areas of capturing quantitative data used to assess overall effectiveness of the overall effort. Programs often provide their own internal form of verification and validation and do not rely on those who are truly independent of the program to give an honest assessment. Also, best business practices need to be applied to provide appropriate management oversight within the Department of Defense to ensure programs stay on track [18].

The following sections describe existing DoD ERP logistics implementation efforts in the Army, Navy, Air Force, and Marine Corps in terms of documentation,

capability, schedules, and cost. All of the programs are attempting to transform the way the services perform the business of logistics management and all have experienced problems, both technical and programmatic, in the implementation of their respective ERP systems. This information shows that Army, Navy, Air Force and Marine Corps logistics IT ERP development efforts have experienced several design and development problems that need to be understood and addressed in future DoD ERP development efforts.

B. SERVICE ERP EFFORTS

ERP development effort information was collected from the Army, Navy, Air Force, and Marine Corps in four main areas of interest; documentation, functionality, cost and schedule. This information establishes a trend regarding service ERP efforts in terms of cost overruns and schedule delays.

1. Army ERP Efforts

The Army is modernizing its logistics business processes in order to provide total asset visibility by implementing two ERP efforts. They are the Global Combat Support System-Army (GCSS-Army), and the Logistics Modernization Program (LMP). These ERP efforts will modernize the Army's logistics IT systems that are over 30 years old. The GCSS-Army program is an ACAT 1-D program [20] and is a tactical effort that will integrate the Army's supply chain, provide equipment readiness reports, and get current status on maintenance actions and supplies in support of the Warfighter [21]. LMP is a wholesale effort that integrates the Army's supply chain and includes the capability to track maintenance activities, as well as provides inventory management, transportation, and warehousing functionality [21]. The following paragraphs highlight the difficulties the Army has had in developing their ERP solutions with respect to GAO key findings, functionality, cost, and schedule.

a. Army ERP GAO Key Findings

There are many products that are required to fully document the requirements of any program. Architecture products are key to not only identifying the

current system and process functionality but also the future or desired functionality the newly developed system is to provide. Over the years, the GAO has documented several findings regarding the inadequacy of architecture development in the DoD. In 2003, the GAO identified that the DoD had yet to establish adequate integrated architecture governance structure and process controls [22]. In 2006, the GAO developed an architecture management framework to increase the effectiveness of managing architecture programs [23]. In 2007, the GAO identified two critical elements that the Army needed to successfully implement the Army logistics ERP; they are an Army level Enterprise Architecture (EA) and a Concept of Operations (CONOPS) [16].

The EA is a key document that provides a blueprint for organizational change. It defines models that represent two states of architecture. One model represents how the Army operates today; the other model describes how the Army intends to operate in the future. The EA should also include a plan on how the Army should transition from today's operations to the future operations. Without an EA, interfaces and dependencies cannot effectively be managed [16].

The CONOPS is the key document that describes how the new system intends to operate to provide total asset visibility. It details how decisions are to be made as well as lay out the new business processes the ERP solution requires to operate in. Without a CONOPS, the Army will have a difficult time in describing the enterprise view of its new systems as well as not describing the total asset visibility or supply chain management processes the Army intends to satisfy using the new ERP systems [16]. Documentation of the new business processes should allow the Army to take advantage of the COTS product's ability to transform the Army's business processes.

Both the EA and the CONOPS are important documents and provide the underlying foundation required to understand the architecture and operation of the ERP system. Per the GAO reports, incomplete or inaccurate information in these documents could be contributors for cost overruns and delays in schedule.

b. Army ERP Functionality

The Logistics Modernization Program replaces two legacy systems that have been in operation for over 30 years, Commodity Command Standard System and the Depot System [16]. There are six core Working Capital Fund processes that the Army intends to transform, they are: order fulfillment, demand and supply planning, procurement, asset management, materiel maintenance, and financial management. When fully deployed in 2011, the LMP program will be used by over 17,000 users in over 1,000 locations [24].

The GCSS-Army program integrates the Army's supply chain and replaces 16 stove-piped legacy logistics systems to include Standard Army Retail Supply System, Standard Army Maintenance System Enhanced, Property Book Unit Supply Enhanced, and Unit Level Logistics System – Aviation Enhanced and Standard Army Ammunition System [20]. It will also eliminate duplicative databases, poor asset visibility, and stove piped communications between the Army logistics systems [16].

The scope of the GCSS-Army program initially was too large to develop as one release. It has been broken down into two main increments with Increment-1 broken down into three releases and Increment-2 yet to be defined [20].

Release 1.0 includes Supply Support Activity (SSA) functionality currently implemented at the B DSU SSA, Regimental Support Squadron, 11th Armored Cavalry Regiment, Ft Irwin, California [20].

Release 1.1 includes Unit Level Supply, Property Book, Maintenance (Aviation and Ground), and finance (support to tactical supply and maintenance) functionality [20].

Release 1.2 includes ammunition, environmental health and safety, finance, and cost management functionality [20].

Breaking down the scope of GCSS-Army will make the development effort manageable and allow smaller increments of capability to be delivered sooner rather than waiting for one very large block of capability to be delivered later.

c. Army ERP Costs

The cost to develop an ERP system is difficult to budget for and difficult to keep within the cost estimate. In 1999, it was reported that approximately 90 percent of ERP implementations were late or over budget [25]. In 2003, GCSS-Army started as a custom software development and $95 million was invested before the program was halted. In 2003, the ERP effort started and as of September 2006, approximately $203 million had been obligated. It is estimated another $2.1 billion will be invested [16]. As of 2006, the LMP ERP effort had obligated about $452 million to develop and implement the program and estimated that it will invest at least another $895 million [16].

Totaling both LMP and GCSS-Army, a total amount of over $3.8 billion will be invested on the development of just these two ERP systems alone. A tremendous amount considering COTS software is being used.

d. Army ERP Schedules

The LMP effort started in 1998 [16]. It has been operational since 2003, and will be fully deployed in 2011. The program will operate in more than 1,000 locations with more than 17,000 users worldwide [21]. Figure 4 shows that the LMP program's Full Operational Capability (FOC) date had been revised three times indicating there were problems with the LMP effort. The revised schedule in February 2006 modified the FOC to 2011, five years longer than the initial estimate of 2006. This is typical of ERP implementations [16].

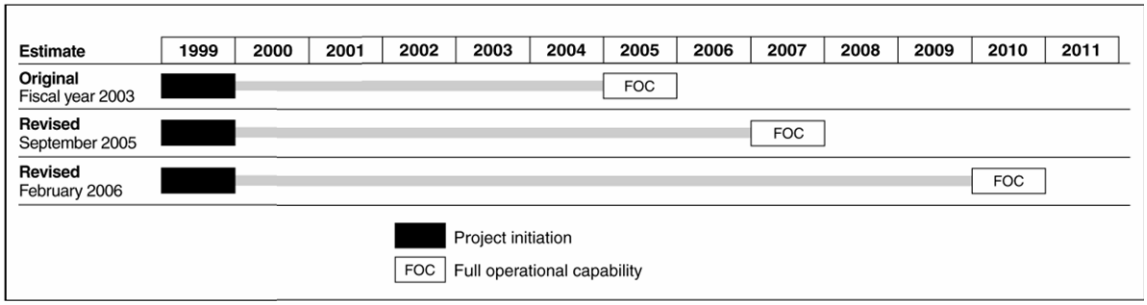

Figure 4. LMP Timeline. From [16]

The GCSS-Army effort started in 1997 as a custom software solution. The commercial ERP effort started in 2003. Figure 5 shows that the GCSS-Army program's Full Operational Capability (FOC) date has also been revised three times indicating there were problems with the GCSS-Army effort. The revised schedule in March 2006 modified the FOC to 2014, five years longer than the initial estimate of 2009 not counting the custom software development initial FOC date [16].

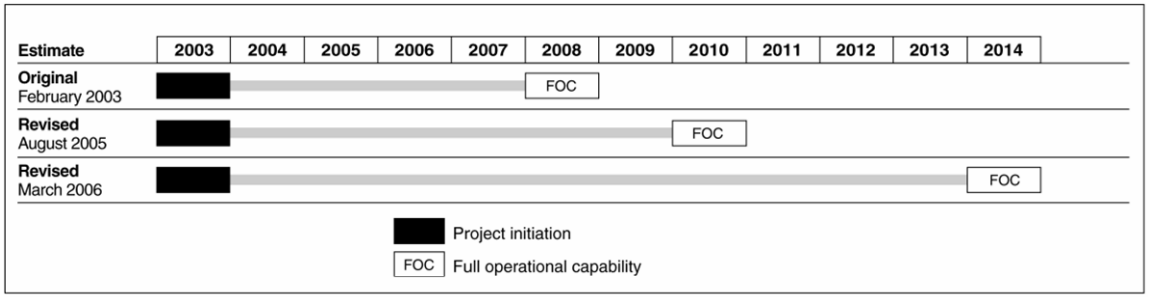

Figure 5. GCSS-Army Timeline. From [16]

Both the LMP and GCSS-Army programs had the FOC event rebaselined three times. This change in Army ERP schedules is consistent with the schedule delays of the ERP efforts of the other DoD Services illustrating that the length of ERP development is not easy to determine and even harder to maintain.

e. Army ERP Effort Summary

The Army is modernizing its logistics business processes in order to provide asset visibility by implementing the LMP and GCSS-Army programs. Both of these ERP systems will replace existing legacy systems some of which are over 30-years old. The Army was missing fundamental documentation such as the Enterprise Architecture, to provide the blueprint for organizational change, and the CONOPS, to describe how the new system intends to operate. The functionality of these ERP systems includes Supply Support Activity functionality, as well as asset visibility, maintenance, finance, and environmental. The scope for the GCSS-Army program was broken down into manageable, smaller increments in order to deliver capability quicker to the user. The costs for the LMP and GCSS-Army programs are estimated to be approximately $1.4B and $2.4B, respectively. Schedule delays have been realized for both the LMP and

GCSS-Army programs. The LMP program schedule revised the FOC date by an additional five years from the original estimate. The GCSS-Army program also revised the FOC date by an additional five years from the original estimate. The Army ERP efforts have experienced inadequate documentation, scope redefinition, cost adjustments, and schedule delays, as shown in Table 1.

Table 1. Army ERP Summary

Area	Summary
ERP Programs	GCSS-Army and LMP
Key Findings	Enterprise Architecture and CONOPS not successfully implemented
Functionality	GCSS-Army Supply Support Activity, Unit Level Supply, Property Book, Maintenance (Aviation and Ground), and finance (support to tactical supply and maintenance) functionality, ammunition, environmental health and safety, finance, and cost management functionality. LMP Order fulfillment, demand and supply planning, procurement, asset management, materiel maintenance, and financial management.
Life Cycle Cost	GCSS-Army: $2.4B LMP: $1.4B
Schedule	GCSS-Army: 3 slips within 3 yrs, FOC slip 3 yrs, total time to FOC – 11 yrs. LMP: 3 slips within 3 yrs, FOC slip 5 yrs, total time to FOC - 11 yrs.

2. Navy ERP Efforts

The Navy planned to reform their business operations. Between 1998 and 2003, four different Navy commands began to plan, develop, and implement four ERP pilot programs [18]. These pilot programs would provide financial management, supply management, regional maintenance, and program management capability for the Navy. They were developed by four separate commands, were developed independently, and duplicated the same functionality. Despite an investment of over $1 billion, the pilot programs were uncoordinated, not integrated, and were deemed a failure by the GAO [18]. The pilot programs had a lack of disciplined processes to include requirements management and customized many areas of the COTS software defeating the purpose of using out-of-the-box functionality [18].

Because the pilot programs did not meet the Navy's overall requirements, the Navy decided to start over and replace the pilot programs with one ERP system under the leadership of a central program office [18]. The replacement Navy ERP solution transitions legacy business processes into a single supply solution and integrates the functionalities of planning, allowancing, procurement, repairables, and order fulfillment [26]. The Navy ERP program developed disciplined processes to identify and manage program requirements. The amount of customization was reduced to allow only modifications that were required legally or regulatory. Minimizing customizations reduced the complexity along with the costs of development [18]. Another area of note was the realization that the four pilot projects used the implementation method of their separate system integrators. This was a huge risk as each implementation differed significantly with respect to the amount and methodology to customize the software. Instead, the new integrated ERP solution would implement the methodology of the COTS vendor to the overall solution to obtain a more robust requirements management process. Requirements can now be linked from the highest level down to the COTS transaction level [18].

The following paragraphs highlight the difficulties the Navy has encountered in developing their ERP solutions with respect to GAO key findings, functionality, cost, and schedule.

a. Navy ERP GAO Key Findings

The Navy did not designate the four pilot programs as Major Automated Information Systems (MAIS) even though they should have been in accordance with DoD policy at the time. Because they were not designated MAIS programs, the Navy never prepared a mission needs statement for any of the pilots [18]. The mission needs statement would have identified the mission requirements and the interoperability needs. The current Navy ERP program is designated a MAIS program and is under the oversight of the OSD and is required to adhere to the OSD acquisition process rules [27]. This designation has increased the probability of success for the program by eliminating the mistakes made early during the pilot project efforts.

b. Navy ERP Functionality

The Navy ERP program is designed using SAP ERP software. It will be developed and implemented in three increments.

Increment 1.0 includes financials, acquisition, billing, budgeting, and cost planning as well as costing, contract awards, and budget exhibits, personnel administration, training, and events management [28].

Increment 1.1 includes wholesale and retail supply, supply and demand planning, order fulfillment, supply forecasting as well as retail supply such as inventory management, supply and demand processing and warehouse management [28].

Increment 1.2 includes Intermediate-Level maintenance, maintenance management, quality management, and calibration management [28].

Increment 1.0 provides financials and acquisition capability for about 36,000 users [26]. Increment 1.1 provides wholesale and retail supply at the Inventory Control Point (ICP) and regional supply centers for aggregate total of about 75,000 users [26]. Increment 1.2 provides Intermediate (I) level maintenance for both Maritime and Aviation for aggregate total of about 80,000 users [26]. When fully implemented, the program will support over 86,000 users [28].

Technical challenges for Navy ERP are implementation of 44 system interfaces (27 Navy specific, 17 DoD specific), see Figure 6, and data conversion from legacy systems into the ERP system.

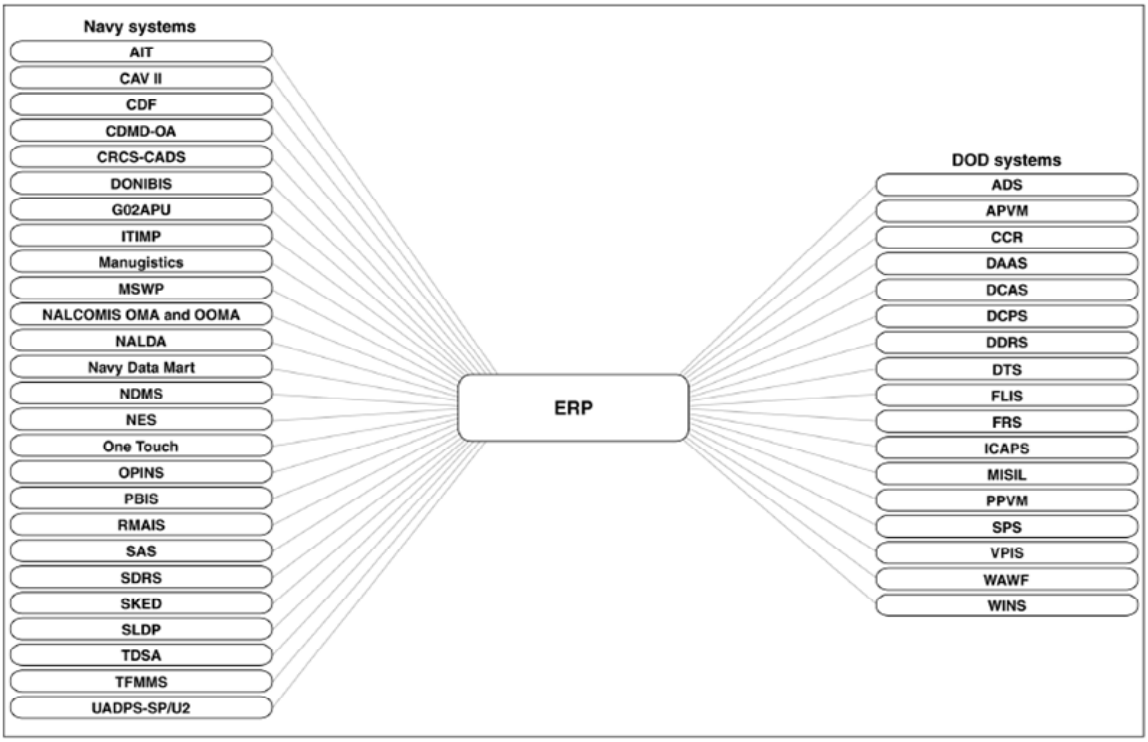

Figure 6. Navy ERP Required System Interfaces. From [18]

Another challenge for the Navy ERP program is not implementing an IV&V function. The Navy ERP program uses in-house subject matter experts and others who are also internal to the program. An independent assessor would be able to provide unbiased information to the DoD and the Navy on the overall status and effectiveness of the management processes [18].

Breaking down the scope of Navy ERP will make the development effort manageable and allow smaller increments of capability to be delivered sooner rather than waiting for one very large block of capability to be delivered later. This also provides faster payback and value to the Navy.

c. Navy ERP Costs

The Navy ERP program was rebaselined three times increasing the expected life cycle cost estimate each time. Figure 7 shows that costs increased from an estimate of $1.873 billion in 2003 to an estimate of $2.44 billion in 2007, an increase of over $570 million [28]. This is another example of how difficult it is to estimate an ERP development effort and in this case, after four pilot projects had already failed to produce a final product.

Figure 7. Navy ERP Life Cycle Cost Estimates. From [28]

d. Navy ERP Schedule

The start date for the Navy ERP program was in 2003 after the four original pilot programs efforts were stopped. At that time, original Navy ERP FOC date was 2011. In 2007, the program was rebaselined and the FOC date was revised to 2013, as shown in Figure 8.

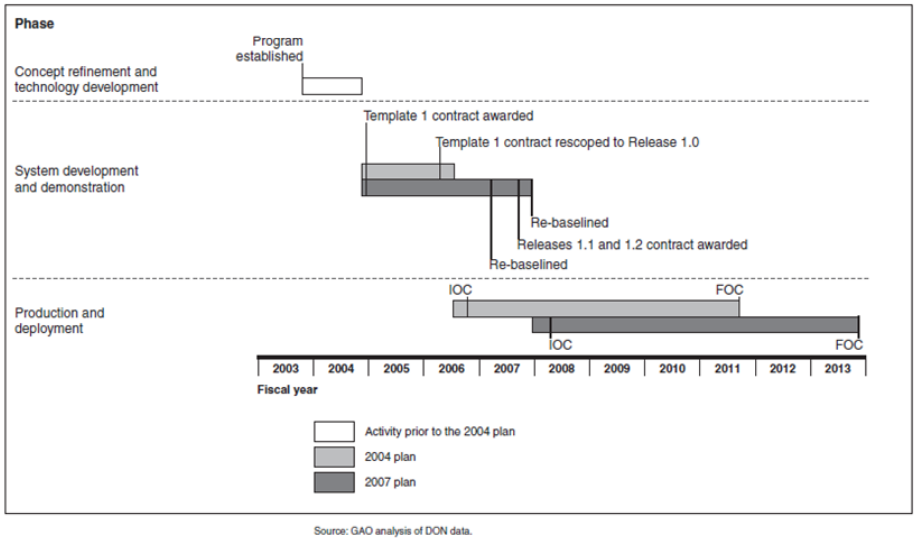

Figure 8. Navy ERP Timeline. From [28]

Once again, here is an example of how difficult it is to develop an accurate forecast for the ERP development and implementation schedule. The revision in the Navy ERP schedule is consistent with the schedule delays of the ERP efforts of the other DoD Services illustrating that the length of ERP development is not easy to determine and even harder to maintain.

e. Navy ERP Effort Summary

The Navy is modernizing its business operations in order to provide financial management, supply management, regional maintenance, and program management capability for the Navy. The Navy was initially missing fundamental documentation such as the mission needs statement to identify mission requirements and interoperability needs. The functionality of these ERP systems includes financials,

acquisition, contracting, wholesale and retail supply and demand planning, warehouse management, and maintenance management. The scope for the Navy ERP program was broken down into manageable, smaller increments in order to deliver capability quicker to the user. Technical challenges include implementing 44 system interfaces and data conversion from legacy systems. The cost for the Navy ERP program is estimated to be approximately $2.44B, an increase of over $570M from the original estimate. Schedule delays have been realized for the Navy ERP program. The FOC date was revised by an additional two years from the original estimate. The Navy ERP effort has experienced inadequate documentation, scope redefinition, cost adjustments, and schedule delays, as shown in Table 2.

Table 2. Navy ERP Summary

Area	Summary
ERP Programs	Navy ERP
Key Findings	Lack of MNS in early pilot programs impacted mission requirements and interoperability needs, IV&V function not implemented, technical challenges in implementation of 44 system interfaces and data conversion from legacy systems.
Functionality	Increment 1.0 includes financials, acquisition, billing, budgeting, and cost planning as well as costing, contract awards, and budget exhibits, personnel administration, training, and events management Increment 1.1: wholesale and retail supply, supply and demand planning, order fulfillment, supply forecasting as well as retail supply such as inventory management, supply and demand processing and warehouse management Increment 1.2: Intermediate-Level maintenance, maintenance management, quality management, and calibration management
Life Cycle Cost	$2.4B
Schedule	Rebaselined once, FOC slipped 2 years, time to FOC is 9 years

3. Air Force ERP Efforts

The Air Force has two commercial off-the-shelf ERP efforts underway using the Oracle E-business suite. They are the Expeditionary Combat System Support (ECSS) and the Defense Enterprise Accounting and Management System (DEAMS). They are components of the Air Force eLog21 systems architecture designed to integrate financials, order management, purchasing, inventory management, distribution, and other business functions of the Air Force onto one platform [29]. Together they will transform the Air Force's logistics and financial management operations and achieve total asset visibility. ECSS provides a single integrated logistics system while DEAMS provides core financial management capabilities. ECSS is considered a key element in the Air Force's efforts to reengineer and transform its supply chain operations from a reactive posture to a more predictive posture that facilitates greater effectiveness and efficiency in the Air Force's logistics operations that support the warfighter [17].

The GAO reported in 2008 several key areas that the ECSS and DEAMS programs needed to improve upon [17]. The GAO stated that the program's Risk Management process was not adequate enough to capture and manage the program's risks well enough prior to those risks being realized within the program. Program risks were managed independently within the working level of the program however the risks were not visible at the program management level of the program [17].

Several potential risk areas were identified. For both ECSS and DEAMS, interfaces were identified and associated risks were managed at the lower program levels, however these interface risks were not consistently identified at the program management level. Technical challenges that were not identified as risk items include DEAMS having 70 interfaces to implement and also the level of effort involved in the data conversion activities. Other challenges not documented as risks include training and the lack of staffing with the required skill sets [17].

The following paragraphs highlight the difficulties the Air Force has encountered in developing their ERP solutions with respect to GAO key findings, functionality, cost, and schedule.

a. Air Force ERP GAO Key Findings

The Air Force strategy to integrate and govern logistics transformation initiatives is stated in the Air Force's Expeditionary Logistics for the 21st century (eLog21) transformation campaign plan [30]. The ECSS and DEAMS programs when implemented will satisfy many eLog21 key objectives such as Air Force-Wide logistics planning, centralized asset management, total asset visibility, and predictive maintenance [30]. The eLog21 serves as a guide that provides a vision to improve Air Force logistics to meet both the current and future threat environments and serves as the foundation from which program requirements are derived from.

While the eLog21 strategy provides an overarching guideline for Air Force logistics business process transformation, the GAO found that key Air Force documentation was not clearly linked together or linked to DoD's Enterprise Transition Plan. Documents such as the Financial Management Strategic Plan, Accountability Improvement Plan, and the Logistics Enterprise Architecture Concept of Operations do not align to the DoD's Enterprise Transition Plan. Without this alignment, the Air Force will have a difficult time achieving DoD's business transformation priorities and goals that include total asset visibility.

b. Air Force ERP Functionality

ECSS and DEAMS is the IT solution to transform its logistics and financial management operations leading to total asset visibility across the Air Force. The ECSS program provides transportation, supply, maintenance and repair, engineering, and acquisition functionality. It will replace 250 legacy logistics and procurement systems and will support over 250,000 Air Force users. The DEAMS program provides financial management and accounting functions for Air Force general fund operations. It has 70 key interfaces and will replace seven legacy systems [17].

The ECSS approach to replacing 250 legacy systems in one development effort may be problematic. As seen with GCSS-Army and Navy ERP, those programs have been broken down into smaller manageable increments of capability. The ECSS approach may take a longer time to deliver a larger block of capability. The ECSS

program will have many more interfaces to manage, much more data conversion of legacy data to deal with, and a tremendous amount of business process realignment to implement by trying to replace so many legacy systems at one time.

c. Air Force ERP Costs

The ECSS program was initiated in 2004. As of 2007, $250 million had been obligated. The ECSS expected total life-cycle cost estimate is over $3 billion as shown in Figure 9. This estimate may go higher as more functionality is planned to be incorporated into ECSS in the areas of financial management control and accountability [17].

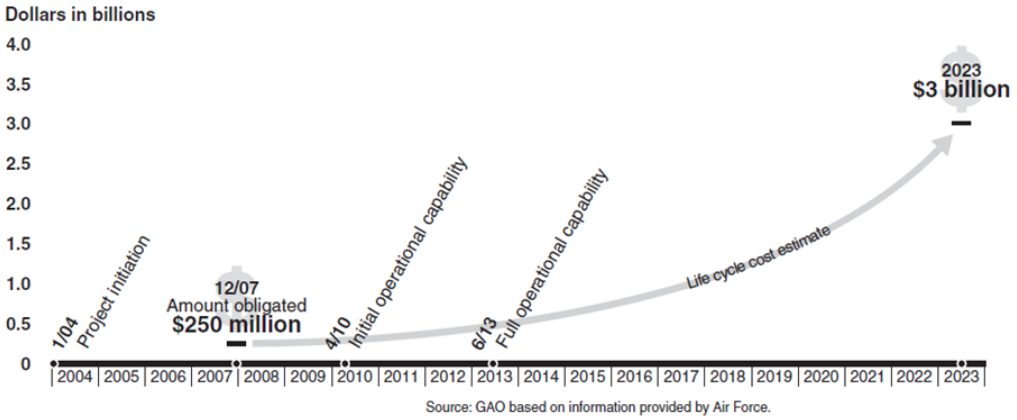

Figure 9. ECSS Funding. From [17]

The DEAMS program was initiated in 2003. As of December 2007, $119 million had been obligated. The DEAMS expected total life-cycle cost estimate is over $1.1 billion, as shown in Figure 10.

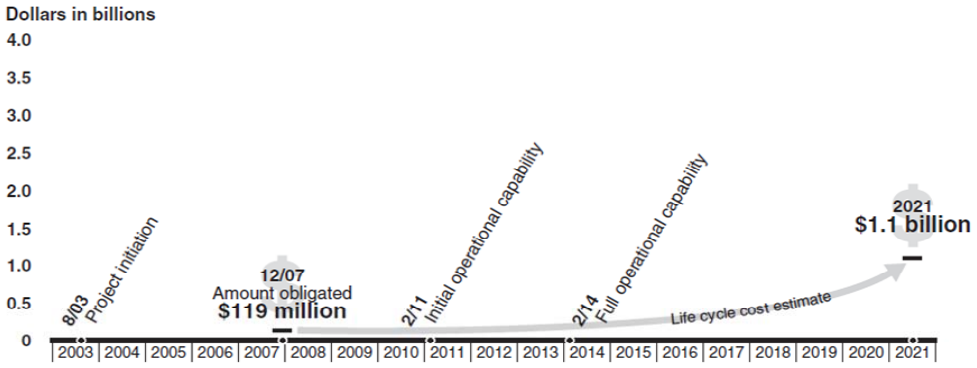

Figure 10. DEAMS Funding. From [17]

d. Air Force ERP Schedules

The ECSS program was initiated in 2004. FOC is estimated to occur in fiscal year 2013 [17]. This is 9 years to complete design, build, test, and fielding to all units within the Air Force. If the program remains on schedule, and all goes well, nine years is probably not too long a time frame to replace 250 legacy systems. However, as other DoD ERP implementations have shown with smaller incremental developments, there are many challenges to overcome and with the scope of ECSS so large, the probability is high that schedule delays will occur.

The DEAMS program was initiated in 2003. FOC is estimated to occur in fiscal year 2014 [17]. This is 11 years to design, build, test, and field to all units within the Air Force. With only seven legacy systems to replace, this may be more realistic that ECSS, and will have a higher probability of success within the allotted time frame.

Here is an example of how difficult it is to develop an ERP IT solution within a relatively short time span. With such long development times, delays can be expected. As seen with the ERP efforts of the other DoD Services even shorter time spans are difficult to manage and meet.

e. Air Force ERP Effort Summary

The Air Force is transforming their logistics and financial management operations in order to achieve total asset visibility by implementing the DEAMS and ECSS programs. The Air Force documentation was missing fundamental linkages to the

DoD's Enterprise Transition Plan and will have a difficult time achieving DoD's business transformation priorities and goals. The functionality of these ERP systems includes financial management, accounting, transportation, supply, maintenance and repair, engineering, and acquisition. The scope for the ECSS program is very large and plans to replace 250 legacy logistics while the DEAMS program plans to replace seven legacy systems. The lifecycle costs for the DEAMS and ECSS programs are estimated to be approximately $1.1B and $3.0B respectively. Schedule delays are likely to be realized for both the DEAMS and ECSS programs. The DEAMS program schedule is estimated to take 11 years to achieve FOC while the ECSS program is estimated to take nine years to achieve FOC. The Air Force ERP efforts have inadequate linkages to DoD documentation, very large scope definition, cost increases, and potential schedule delays, as shown in Table 3.

Table 3. Air Force ERP Summary

Area	Summary
ERP Programs	ECSS and DEAMS
Key Findings	Documentation was not clearly linked together or linked to DoD's Enterprise Transition Plan. Documents such as the Financial Management Strategic Plan, Accountability Improvement Plan, and the Logistics Enterprise Architecture Concept of Operations do not align to the DoD's Enterprise Transition Plan.
Functionality	<u>ECSS</u> Provides transportation, supply, maintenance and repair, engineering, and acquisition functionality. Replaces 250 legacy logistics and procurement systems. <u>DEAMS</u> Provides financial management and accounting functions for Air Force general fund operations. It has 70 key interfaces and replaces 7 legacy systems.
Life Cycle Cost	ECSS: $3B DEAMS: $1.1B
Schedule	ECSS: time to FOC is 9 years DEAMS: time to FOC is 11 years

4. Marine Corps ERP Efforts

The GCSS-MC program is the only ERP effort currently being developed in the Marine Corps and provides the baseline for the modernization of Marine Corps logistics IT systems. It delivers integrated logistics functionality primarily in the areas of supply and maintenance. It provides timely and accurate logistics information and is accessible by troops in garrison or deployed to austere environments. When fully implemented, about 33,000 users around the world will have access [15].

a. Marine Corps GAO Key Findings

In 2008, the GAO identified IT management weaknesses with the GCSS-MC program. Two key weaknesses were management of earned value and management of risks. The program was not able to adequately measure program progress based on actual work performed therefore program completion dates could not be projected accurately increasing the likelihood of program delays. The GAO also found that there were many risks that had not been adequately managed and that the mitigation steps for major risks either had not been implemented or proved ineffective and this allowed risks to become actual problems and reclassified into issues. Assessing schedule risk and allocating schedule reserve to address these risks within the schedule could not be adequately measured, and the GAO believed it likely that program completion dates could not be projected [15].

b. Marine Corps ERP Functionality

Per the GCSS-MC ORD and CDD, the GCSS-MC development effort is defined as 3 major blocks of capability. These blocks deliver integrated functionality across retail and wholesale supply, maintenance, warehousing, transportation, finance, engineering, health, acquisition and manpower systems [10, 31]. Block 1 replaces four existing logistics IT systems and its functionality is further defined as:

- Requesting and tracking the status of products (e.g., supplies and personnel) and services (e.g., maintenance and engineering);
- Allocating resources (e.g., inventory, warehouse capacity, and personnel) to support unit demands for specific products; and
- Scheduling maintenance resources (e.g., manpower, equipment, and supplies) for specific assets, such as vehicles [15].

GCSS-MC Blocks 2 and 3 are not yet defined and are not planned for development until FY12.

c. Marine Corps ERP Costs

Cost for the GCSS-MC Block 1 program had been revised three times within three years. GCSS-MC originally planned to reach FOC in fiscal year 2007 at an estimated cost of about $126 million over a 7-year life cycle [15]. This estimate was later revised in 2005 to about $249 million over a 13-year life cycle [15]. At the time of the GAO report in 2008, the program expects to reach FOC in fiscal year 2010 at a cost of about $442 million over a 12-year life cycle [15]. Figure 11 shows the program's life cycle cost estimate for Block 1 against original and revised milestones.

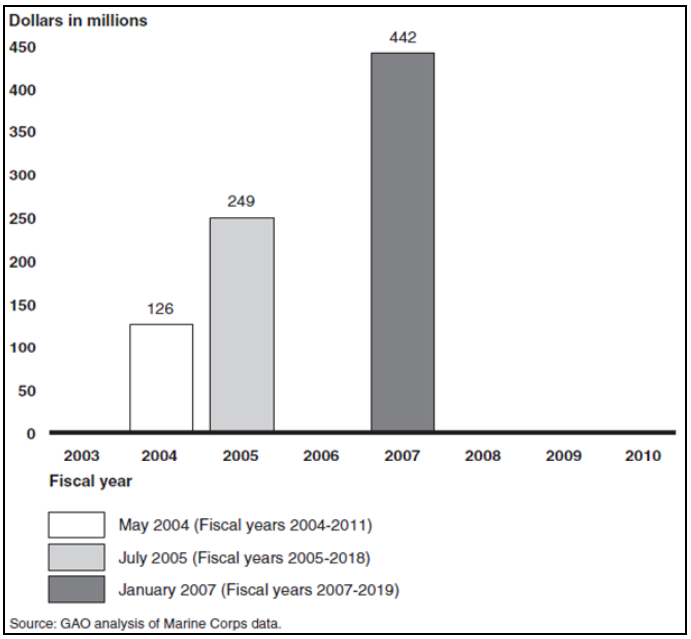

Figure 11. GCSS-MC Program Cost Status. From [15]

In 2010, in preparation for Milestone C, the GCSS-MC program revised its life cycle cost estimate and submitted a proposed Acquisition Program Baseline that revised the life cycle cost estimate to $1.022B [32]. This was more than double the previous estimate and about 10 times more than the original estimate in 2003.

d. Marine Corps ERP Schedules

The GCSS-MC Block 1 program experienced delays early in the program, as shown in Figure 12. In 2004, FOC was expected in 2007, but the program was rebaselined in 2006 and moved the FOC date to 2010, delaying the program by 3 years [15].

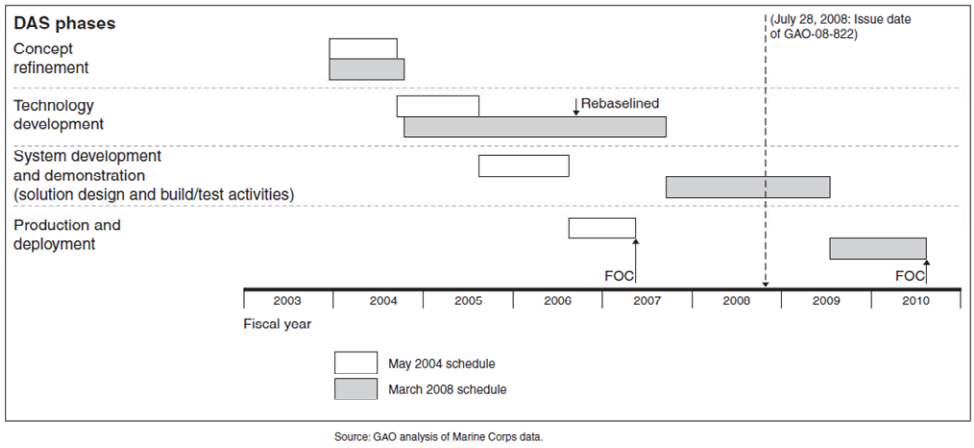

Figure 12. GCSS-MC Program Schedule Status. From [15]

The GCSS-MC program would experience many more delays at almost every key event in the acquisition process. Starting with the 2003 ORD schedule and ending with the latest schedule that appears in the 2010 Acquisition Program Baseline, the FOC for the program was delayed approximately seven years and the total time to FOC for the program was revised to about 10 years. This schedule delay pattern is consistent with the schedule delays of the ERP efforts of the other services. The progression of this schedule delay is outlined in the Research Analysis section of this thesis.

e. Marine Corps ERP Effort Summary

The GCSS-MC program is the only ERP effort currently being developed in the Marine Corps and provides the baseline for the modernization of Marine Corps logistics IT systems. It delivers integrated logistics functionality primarily in the areas of supply and maintenance. The GAO determined that schedule risk could not be adequately measured and that it was likely that program completion dates could not be projected accurately. An updated LCCE in 2010 more than doubled the previous estimate and was about 10 times more than the original estimate in 2003. There have been many delays in the GCSS-MC schedule. The FOC for the program was delayed approximately seven years and the total time to FOC for the program was revised to about 10 years. Table 4 summarizes the GCSS-MC ERP development effort.

Table 4. GCSS-MC ERP Summary

Area	Summary
ERP Programs	GCSS-MC
Key Findings	Management of earned value and risks were weaknesses and indicative of a program unable to stay on schedule
Functionality	Retail and wholesale supply, maintenance, warehousing, transportation, finance, engineering, health, acquisition and manpower systems
Life Cycle Cost	$1.022B
Schedule	Time to FOC is 10 years, delayed 7 years from original estimate

C. CHAPTER SUMMARY

Modernization of service legacy logistics IT systems using ERP technology has proven to be a challenge to keep on schedule and on budget. The Army, Navy, Air Force, and Marine Corps all have similar requirements and trying to implement similar functionality. Table 5 shows a side-by-side comparison of the four services.

Table 5. DoD Services Implementation Summary

	Army	Navy	Air Force	Marine Corps
GAO Key Findings	Enterprise Arch and CONOPS not successfully implemented	Lack of MNS in early pilot programs impacted mission requirements and interoperability needs IV&V function not implemented Technical challenges in implementation of 44 system interfaces and data conversion from legacy systems	Documentation was not clearly linked together or linked to DoD's Enterprise Transition Plan. Documents such as the Financial Management Strategic Plan, Accountability Improvement Plan, and the Logistics Enterprise Architecture Concept of Operations do not align to the DoD's Enterprise Transition Plan.	Weak management of earned value and risk

	Army	Navy	Air Force	Marine Corps
Functionality	GCSS-Army Supply Support Activity, Unit Level Supply, Property Book, Maintenance (Aviation and Ground), and finance (support to tactical supply and maintenance) functionality, ammunition, environmental health and safety, finance, and cost management functionality. LMP Order fulfillment, demand and supply planning, procurement, asset management, materiel maintenance, and financial management.	Increment 1.0 Financials, acquisition, billing, budgeting, and cost planning as well as costing, contract awards, and budget exhibits, personnel administration, training, and events management Increment 1.1 Wholesale and retail supply, supply and demand planning, order fulfillment, supply forecasting as well as retail supply such as inventory management, supply and demand processing and warehouse management Increment 1.2 Intermediate-Level maintenance, maintenance management, quality management, and calibration management	ECSS Provides transportation, supply, maintenance and repair, engineering, and acquisition functionality. Replaces 250 legacy logistics and procurement systems. DEAMS Provides financial management and accounting functions for Air Force general fund operations. It has 70 key interfaces and replaces 7 legacy systems.	Block 1 Retail and wholesale supply, maintenance Future Blocks Warehousing, transportation, finance, engineering, health, acquisition and manpower systems.
Service Cost	$3.8B	$2.4B	$4.1B	$1.022B
Schedule	GCSS-Army: 3 slips within 3 years, FOC slip 3 years, total time to FOC is 11years. LMP: 3 slips within 3 years, FOC slip 5 years, total time to FOC is 11 years.	Rebaselined once, FOC slipped 2 years, time to FOC is 9 years.	ECSS: time to FOC is 9 years DEAMS: time to FOC is 11 years.	Time to FOC is 10 years, delayed 7 years from original estimate.

All four Services have exceeded their initial cost estimates as well as experienced delays in schedule. While this may not seem unusual in the development of IT systems in general, there does appear to be a pattern emerging with ERP systems running over cost and schedule.

The next chapter identifies GCSS-MC system engineering challenges regarding the technical and functional requirements and the complexity of implementing those requirements. The complexity of the development effort is a large contributor to the cost overruns and schedule delays.

THIS PAGE INTENTIONALLY LEFT BLANK

III. GCSS-MC SYSTEM ENGINEERING IMPLEMENTATION CHALLENGES

A. INTRODUCTION

The GCSS-MC program chose a COTS ERP product as the best alternative to modernize Marine Corps logistics IT systems and satisfy the program requirements documented in the GCSS-MC ORD and CDD. The functional and technical requirements have remained constant over the life of the program and the requirements are traceable between the documents. As the program progressed through the design, build and test phases, implementation of those requirements was not as easy as originally thought. The program was unable to achieve a MS B decision five years after achievement of MS A thus breaching and forcing a rebaseline of the program. This chapter discusses the reasons for choosing a COTS product, requirements documentation, the functional and technical requirements, and the customization of the ERP software needed to meet the Marine Corps required functionality. It is the ambiguity of the program requirements and the complexity of implementing those requirements that causes the program to run over cost and schedule.

B. ANALYSIS OF ALTERNATIVES

In May 2004, the GCSS-MC Program Office performed an Analysis of Alternatives to determine the appropriate material solution that would meet the requirements defined in the September 2003 GCSS-MC ORD. The five alternative solutions of Status Quo, Upgrade Legacy, Custom Implementation, COTS, and Outsource were narrowed down to three for evaluation. The results shown in Table 6 lead the Program Office to choose a COTS solution as it met the most intended scope of the system and had the highest return on investment [33].

Table 6 AOA Results Summary. From [33]

Area of Analysis	Alternative 1 Status Quo	Alternative 3 Custom	Alternative 4 COTS
Risk (1-100)	79	43	51
Functional Requirements (1-500)	178	339	391
Non-Functional Requirements (1-500)	141	307	349
ROI	0	6.33	17.28
Additional Discriminators			
Estimated Cost (Rank)	1	3	2
Breakeven (w/Benefits)	3 (Infinite)	2 (2010)	1 (2008)
Discriminator Total	4	5	3

The AOA analysis results in Figure 13 give a direct comparison of the data and clearly show the COTS solution as the desired implementation of choice.

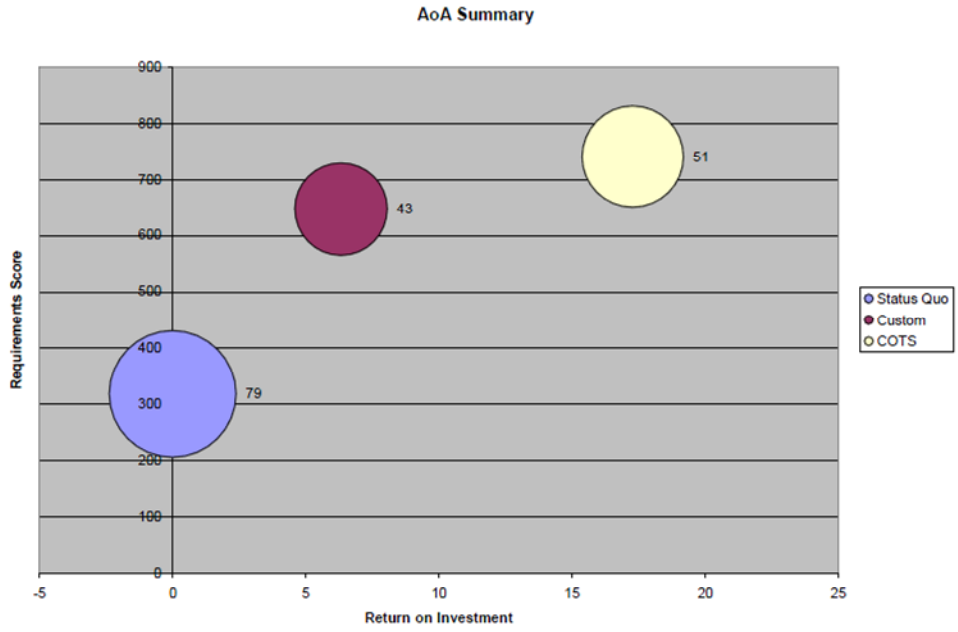

Figure 13 GCSS-MC AOA Analysis Results. From [33]

With the COTS ERP material solution chosen, the Marine Corps developed requirements and codified them in the May 2005 GCSS-MC CDD. The CDD requirements were used as a baseline for defining program cost, schedule, and

performance. A COTS implementation was believed to provide several economic benefits and avoid pitfalls associated with the conversion of legacy systems to a modern architecture. With fewer errors in legacy data conversion, problems of being over budget, behind schedule, and technologically inefficient would be avoided [33]. However, as shown later in this chapter, the Program Office would face challenges not only in meeting a defined schedule but in the planning of a realistic schedule that would meet acquisition guidelines contrary to the conclusions in the AOA.

C. REQUIREMENTS DOCUMENTATION

The GCSS-MC program has well documented requirements that have remained stable throughout its development. While the program has had its difficulties in maintaining cost and schedule, the core requirements never changed. Many programs suffer from requirements creep but the GCSS-MC program has stayed true to its root requirements.

The 1997 Mission Need Statement (MNS) defined a need to modernize the Marine Corps logistics and Combat Service Support (CSS) information technology capabilities and to eliminate "stove-piped" development of information technology systems [10]. The MNS established the foundation for all future GCSS-MC requirements development.

In 2000, the GCSS-MC Mission Area (MA) Initial Capabilities Document (ICD) was approved and defined Combatant Command logistical area functions required for execution by the MAGTF. In 2003, the GCSS-MC Operational Requirements Document (ORD) established the capabilities for GCSS-MC Logistics Chain Management (LCM) and provided the information technology capabilities necessary to execute MAGTF CSS functions in expeditionary, joint, and combined environments.

The ORD defined three major blocks of capability and, in December 2003, a System Subsystem Specification (SSS) was developed to translate those high level blocks of capability into lower level functional and technical requirements for all three blocks. The GCSS-MC/LCM program received Milestone A approval for the first block of capability on 23 July 2004 from the Milestone Decision Authority, the Assistant

Secretary of Defense, Networks and Information Integration. In May 2005, a Capability Development Document (CDD) was created to establish requirements for the first block of capability [10]. The CDD requirements are broken down into business process subsystem requirements that are translated to component level requirements. The GCSS-MC requirements documentation tree is shown in Figure 14.

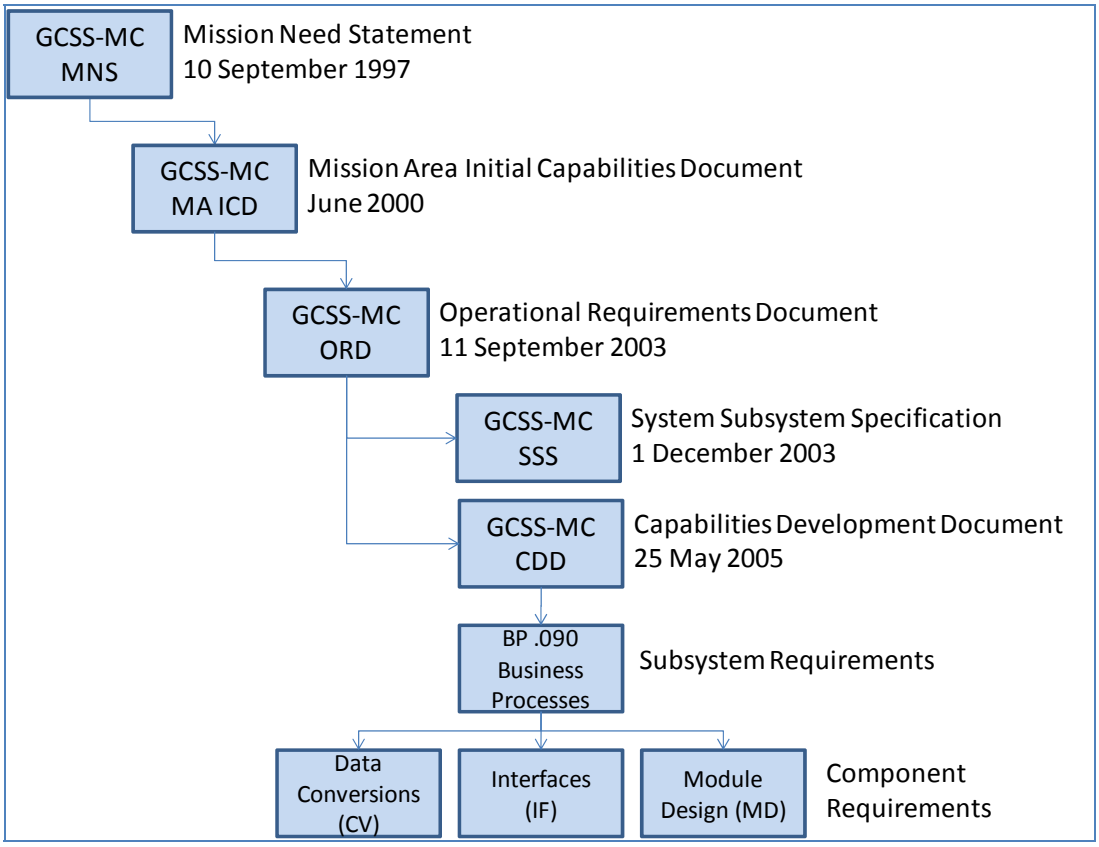

Figure 14. GCSS-MC Requirements Documentation Tree

The GCSS-MC program follows the traditional "V-Model" for development and testing of requirements. Requirements are defined, categorized, and traced in detail from business requirements to component requirements as shown in Figure 15 [34]. Component requirements consist of Reports, Interfaces, Conversions, Extensions (RICE) objects that constitute the customization of the ERP software to perform the Marine

Corps logistics business operations. It is the development of the RICE objects that define the complexity of the ERP design, as shown later in this thesis.

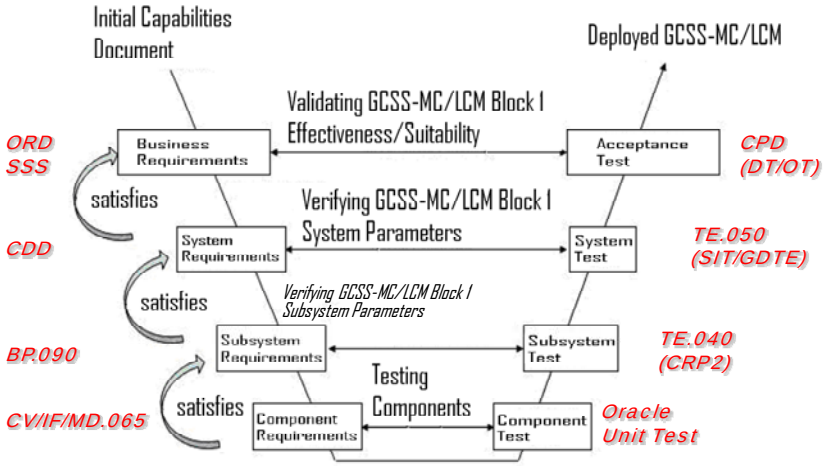

Figure 15. GCSS-MC "V-Model". From [34]

All requirements are captured in a traceability tool from IBM called Rational DOORS®. The Functional Baseline consists of configuration and business procedure documents traceable to a TE.040 test document. The Technical Baseline consists of system and sub-system architecture and management documents traceable to a TE.054 test document. And the RICE baseline, derived from configuration documents, is traceable to a TE.050 test document. The GCSS-MC program has a well established requirements baseline along with a solid traceability effort, as shown in Figure 16 [34].

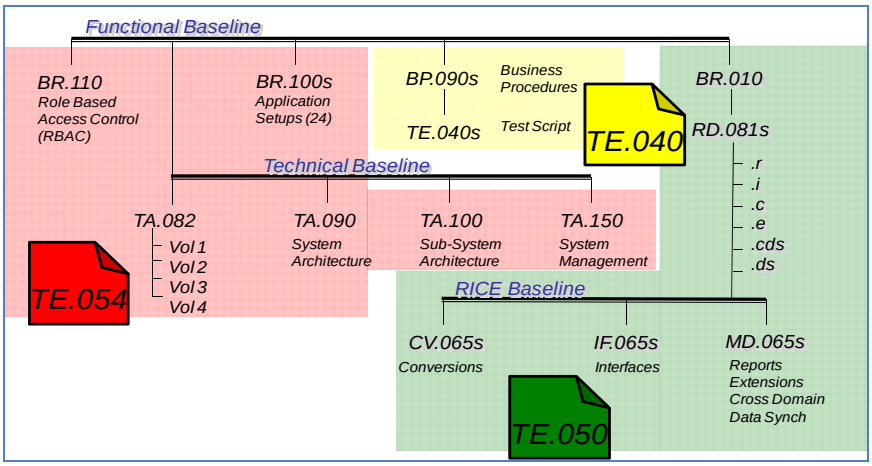

Figure 16. GCSS-MC Traceability. From [34]

GCSS-MC is built upon a COTS ERP solution that delivers integrated functionality across retail and wholesale supply, maintenance, warehousing, transportation, finance, engineering, health, acquisition and manpower systems [10]. Accomplishing the development of all of these capabilities in a single effort is very large and would take several years to accomplish. The COTS ERP software is designed with flexibility such that increments of capability can be developed and implemented in an individual fashion. The GCSS-MC program office took advantage of this flexibility and divided the development effort into three major blocks of functional capability shown in Table 7:

Table 7. GCSS-MC Block Definition. After [31]

Block	Capability
Block 1	Retail Supply and Maintenance. Deployed environment using SIPRNET and NIPRNET.
Block 2	Wholesale Inventory Management, Depot Operations, Warehousing, Transportation, Enhance Order and Inventory Mgmt.
Block 3	Advanced Logistics Planning, Engineering, Medical.

These three blocks provide the Marine Corps with total Logistics Chain Management of all commodities. The functional and technical non-functional requirements discussed in Section D provide the baseline capability required by the ERP

system. It is the uniqueness of these requirements that causes the ERP out-of-the-box software to be customized with the development of RICE objects. Section D discusses the complexity of implementing the RICE objects and that proves to be a large challenge for the GCSS-MC System Engineering team.

D. REQUIREMENTS

The requirements for the GCSS-MC program are represented by two main categories, Functional and Technical/Non-Functional. The main purpose of GCSS-MC is to provide the basic logistics functions of logistics chain management, specifically, the ability to order and track supplies and the ability to schedule and track maintenance. The ERP software can perform those basic functions out-of-the-box. There are, however, other requirements that are levied upon a DoD ERP implementation that make the development effort complex. They are described below in terms of the documented GCSS-MC functional and technical requirements.

1. Functional Requirements

The GCSS-MC functional requirements are defined by four categories:

- Top Level Capabilities
- Joint Financial Management Improvement Program (JFMIP)
- Standard Financial Information Structure (SFIS)
- Resource Financial Accounting (RFA).

The Top Level Capabilities provide the baseline functional requirements necessary for the system to perform logistics operations and are established in 11 functional areas defined by the GCSS-MC CDD [10]. These functional areas include the basic logistics functions of Inventory Planning, Demand Planning, Mission Planning, Maintenance Management and Planning, Asset Management, Inventory Management, Service Management, Financial Resource Management, Warehouse Management, Reporting System Management, and System Management. The ERP software is very capable of providing this basic functionality. The Marine Corps had an existing logistics

chain management process in place, however, and the ERP software had to be modified to exercise that process. Other complexities are introduced when DoD financial requirements (JFMIP, SFIS, and RFA) are placed on the program.

The JFMIP requirements define the financial management practices in government. Specifically it is "… a joint and cooperative undertaking of the U.S. Department of the Treasury the General Accounting Office, the Office of Management and Budget, and the Office of Personnel Management, working in cooperation with each other and other agencies to improve financial management practices in government" [35]. The JFMIP guides financial management improvement across government and explains Federal needs by providing agencies information to improve their financial systems.

The SFIS requirements standardize financial reporting across DoD by ensuring a comprehensive "common business language" is used for budgeting, financial accounting, cost/performance management, and external reporting across the DoD enterprise [36]. The intent of SFIS is to standardize financial reporting across DoD and reduce the cost of auditing. To be compliant means the ERP program must implement the SFIS business rules and values in the Business Enterprise Architecture. There are 71 data elements in SFIS and they all have specific business rules that address syntax, usage and relationships [36]. The SFIS requirements are not part of the ERP out-of-the-box baseline and require customization of the ERP software, an unexpected part of the design effort for GCSS-MC.

The RFA requirements ensure that IT systems comply with regulatory financial policies and procedures [37]. Once again, not part of a normal ERP out-of-the-box baseline and cause for additional customization of the ERP software.

The total number of Functional Requirements derived from these four functional categories is shown in Table 8.

Table 8. GCSS-MC Functional Requirement Count. After [34]

Requirement Type	Total
Top-level Capability	681
JFMIP	315
SFIS	36
RFA	53
Total	1,085

These 1,085 requirements represent the functional capability required to be provided by the ERP system for GCSS-MC to perform the core capability of supply and maintenance logistics chain management. Once these functional requirements are designed, built, tested, and operational, the foundation is set for incorporation of other capabilities. It is the uniqueness of these functional requirements that requires customization of the ERP software. Any modification to the baseline ERP software means additional development time is required and is an opportunity to introduce complexity and error in the development phase of the project.

2. Technical / Non-Functional Requirements

GCSS-MC is comprised of several key technical components consisting of data capture using AIT and the use of a shared data environment accessible via the World Wide Web. The Joint Technical Architecture (JTA) framework that defines operational, system, and technical architecture views is used to describe and define the GCSS-MC system [31].

GCSS-MC technical requirements are defined by five categories:

- Technical
- Joint Data Element (JDE) Reporting
- Information Assurance (IA)

- Net Ready (NR) Key Performance Parameter (KPP)
- Visibility KPP

Technical requirements are those requirements that describe technically how the system is to operate. The system must have the ability to be accessed from both a garrison and deployed environment and must be able to synchronize data between the two environments. Data rates must be in accordance with agreed upon interface controls and continuity of operation must be in place to ensure continuous access to the system. The requirement to access the system from a deployed environment is very unique to the DoD since troops are always on the move, within an austere environment, with normally a poor communications infrastructure. This is not normally built into a COTS piece of software and requires an extensive research and architecture design effort to properly customize the ERP software.

JDE reporting requirements are specific data elements required to be provided to the GCSS-Joint program. Visibility and location of equipment within a theater are required to be seen by Joint forces. Availability and accessibility of Marine Corps prepositioned assets must also be visible to Joint forces. The JDE requirements add additional data fields to the baseline COTS software and require additional interfaces to pass that data forward. This extensive modification to and configuration of the COTS software introduces complexity into the system design.

Information assurance requirements are very extensive due to vulnerabilities from technology threats and must be applied throughout the system life cycle. IA requirements represent the majority of the GCSS-MC technical/non-functional requirements. They must be in accordance with DoD IA and acquisition policies and regulations in order to protect the mission data [31].

There are two GCSS-MC Key Performance Parameters. The first is the Net Ready KPP. This states that data-sharing of Net-Centric Operations, Warfare Reference Model, and GIG Key Interface Profiles will be satisfied to the requirements of specified Joint integrated architecture products and information assurance accreditation [13]. The second is the visibility KPP. When connected to GCSS-MC LCM Deployed or

Enterprise instances, transactions are visible to authorized users after entry by its originator within 60 minutes 95% of the time [13]. These two KPPs bring into play the Joint aspect of data sharing and technically the ability to view transactions that are dependent on the architecture of the network. Both KPPs require customization of the COTS software and increase the development effort of the ERP software.

The total number of Technical Non-Functional Requirements is shown in Table 9. These 290 Technical Non-Functional requirements represent the physical and logical architecture required to meet the intent of the GCSS-MC ORD. These requirements provide an operational architecture that enables the functional requirements to provide the deployed warfighter the ability to request and track the status of supplies and services in an austere environment.

Table 9. GCSS-MC Technical Non-Functional Requirement Count. After [34]

Requirement Type	Total
Top-level Capability	129
JDE Reporting	23
Information Assurance	133
NR KPP	3
Visibility KPP	2
Total	290

The Marine Corps requirement to deploy, move, and stand-up capability in an austere environment is not typical for a public company in industry and proves to be the biggest challenge in this ERP software development. Hence significant customization is required.

E. CUSTOMIZATION (RICE)

COTS software by definition is usage of the software, as is, bought straight off the shelf. There are two approaches an organization can take when implementing COTS software, minimal customization of the software that requires a potential change in organizational business processes, and extensive customization of the software to mimic the organizations existing business processes.

The minimal customization approach would save much time and effort in the design and development phase and would ensure compatibility of future version upgrades of the software. However, this is a very large change management effort and users have to be retrained in the new business processes required to operate the new software.

The extensive customization approach is to have the software mimic the organizations existing business processes. This extensive customization requires a large software development effort that could take a long time to implement and makes future upgrades challenging and technically more difficult [38]. This is the approach of the GCSS-MC program.

The extensive customization approach requires modification of the ERP software by developing unique Reports, Interfaces, Conversions, and Extensions commonly referred to as RICE objects. RICE objects can be complex and a large number of RICE objects can make the ERP implementation very difficult and time consuming.

Reports are outputs from the ERP software that provide information about the data that has been entered [39]. Many existing reports may be used within the new ERP software but new reports may need to be created if unique data fields have been utilized or reports from legacy systems need to be recreated. Existing legacy reports need to be cataloged and analyzed to determine if that report is still needed in the ERP. The ERP may offer a better way to output data and legacy reports may not be necessary to create. Legacy reports should also be prioritized so that the focus of the initial ERP implementation is on the essential reports and not the nice-to-have reports.

Interfaces may be required to link external systems to the ERP software. An interface can be as simple as data exported from the external system and imported into

the ERP system. An interface can also be very complex if the data movement needs to be synchronized between the two systems [39]. The more interfaces, the more technically challenging the ERP software development and the more complex the ERP development and maintenance. Interfaces can also be troublesome since the ERP system has no control over any interface modifications performed on the other end. A rigorous configuration management process needs to be in place to ensure all changes to either end of the interface do not cause adverse effects on either system.

Conversions are a deceiving area of implementation and one of the most costly areas of implementation [39]. Data clean up is a costly area of implementations in terms of labor, the more records the more time consuming [39]. Does the ERP software have all the required data fields? Does the legacy data to be transferred conform to the ERP standard data format? A standard data import template can be used to map data fields to and ensures a consistent, repeatable process to move data from the legacy system. If the data to be moved is from a very old system, it needs to be parsed and corrected and that can be very time consuming [39].

Extensions provide additional functionality that does not exist in the ERP software. Often functionality required from the old system does not exist in the ERP software and is needed to perform a very specific task. In these cases, a separate program must be developed using the tools contained in the ERP system and data hooks are created to link the extension to the core ERP [39]. Extensions should be avoided if possible [39]. GCSS-MC has 36 extensions in the Block 1 release which seems to be high since extensions of any kind should be avoided.

Reports, Interfaces, Conversions, and Extensions are important and necessary in ERP implementations and need to be scoped early in the initial planning phase. Insufficient time in the schedule or lack of resources can have a detrimental impact on the overall implementation budget [39].

The GCSS-MC Program Office selected the Oracle 11i E-Business Suite as the IT solution for modernizing the Marine Corps Logistics IT Systems. The Oracle product was selected in part because it is COTS and comes with an integrated suite of capability

that the Marine Corps thought could be used without much modification. However, as seen in this chapter, a COTS product does not satisfy the functional and technical requirements of the Marine Corps out of the box and requires much customization in the form of RICE objects. The RICE objects can be very complex given that the Oracle COTS product was designed for best commercial practices in the public sector instead of for the very specific Marine Corps business processes currently in place, some of which have been used over the past 30 years with their existing IT systems.

One of the first efforts the Program Office performed was a fit-gap analysis. This effort consisted of comparing the GCSS-MC requirements against the capabilities of the Oracle ERP software. If the Oracle ERP software could not perform the function required by the Marine Corps requirement, it was called a gap and the software would be modified to meet the requirement with a Report, Interface, Conversion, or Extension object. Throughout the development cycle of the GCSS-MC program, requirements were continuously reviewed and software design closely monitored to ensure all requirements were being met. During the operational analysis (OA) phase of the program, a total of 1,237 requirements were identified. Approximately 90% of them were deemed to be a "fit" leaving the rest to be "gaps" implemented using a RICE object. Table 10 breaks down the fit-gap percentages of the requirements.

Table 10. OA Phase Fit-gap Requirements

	# Requirements	# Fit	# Gap	% Fit
Request Management	158	137	21	87%
Supply	515	482	33	94%
Maintenance	216	183	33	85%
Finance	189	165	24	87%
System Admin	159	146	13	92%
Total	1237	1113	124	90%

As the program progressed, the number of requirements was refined and the Fit/Gap percentage evolved as shown in Figure 17 [40]. It is interesting to note that there is an 83% fit of the GCSS-MC requirements to the COTS out-of-the-box software. That may appear to be a very good fit but it's not only the number of RICE objects that determine the size of the design effort but the complexity of the customization required.

Fit/Gap Analysis (FUE/IOT&E Implementation Phase) 7 Oct 2009	
Rqmts	959
Fit	794
Gap	165
Fit %	83%
RICE	101

Figure 17. Fit/Gap Analysis

With only an 83% fit of the requirements to the ERP software capability, development and implementation of the RICE objects was critical to the success of the GCSS-MC effort. Almost 20% of the GCSS-MC requirements required RICE objects and this meant a more complex design and implementation. It was this complex design that drove the project cost overruns and schedule delays. The Program Office recognized the complexity and decided to design and implement the Block 1 effort in two releases as shown in Figure 18 [41].

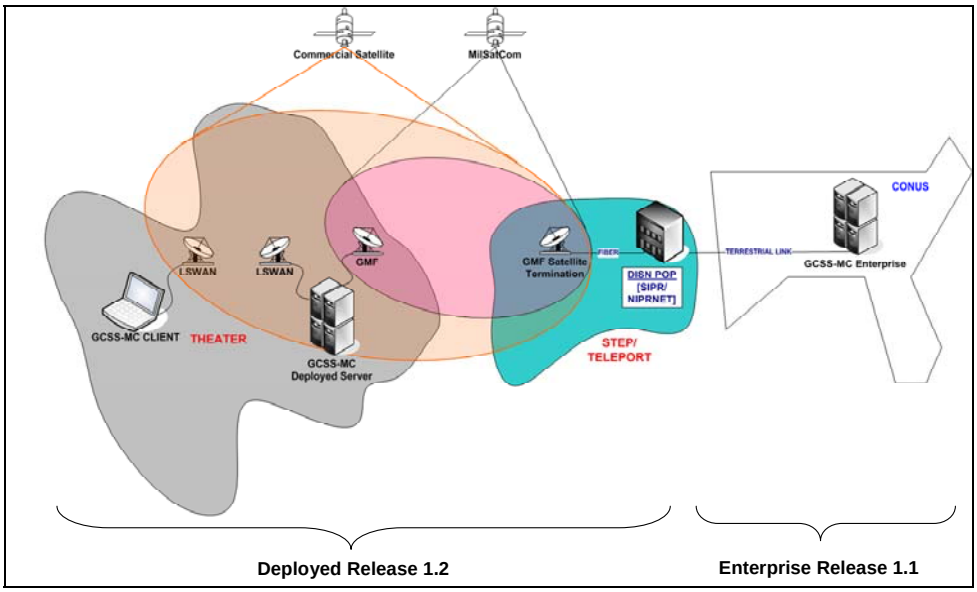

Figure 18. GCSS-MC Two Release Strategy. From [41]

The two release strategy allowed the Program Office to field the baseline functional capability and get the system to users quicker while continuing to develop the much more difficult technical aspects of deployment with a multiple instance architecture incorporating the data synchronization and SIPRNET capability. Table 11 shows the allocation of RICE objects between the two releases. The more technically challenging Data Synchronization and Cross Domain Solution were moved into Release 1.2 allowing the baseline functionality of Reports, Interfaces, Conversions, and Extensions to be developed in a timely manner.

Table 11. RICE Allocation

RICE Type	Release 1.1	Release 1.2
Cross Domain Solution	0	8
Data Synchronization	1	34
Reports	18	1
Interfaces	29	13
Conversions	17	1
Extensions	35	1
Total	100	58

With the technically challenging RICE objects of cross domain solution and data synchronization moved into Release 1.2, the GCSS-MC program can field the basic capability of supply and maintenance management sooner to the war fighter and speed up the process of eliminating the legacy supply and maintenance systems.

F. GCSS-MC SCHEDULE HISTORY

The GCSS-MC program projected a delay in schedule with almost every acquisition document produced or at each milestone event. Each new schedule produced reinforces the fact that the initial or previous schedule was unrealistic. This can be due to

many factors such as expectations from the Marine Corps to hold fast to desired dates and the program office's day to day challenges of implementing an ERP system. The following sections describe the chronological events and corresponding acquisition documents that represent the important milestone dates at that time. A trend emerges as the milestone dates change constantly ultimately causing a breach in program schedule and forcing the program to rebaseline.

1. Pre-Milestone A

According to the GCSS-MC ORD dated September 2003, the IOC for GCSS-MC will be at the end of fiscal year 2004 and the FOC for GCSS-MC will be during FY-2006 [31]. The plan is to field GCSS-MC to 35,000 users at three Marine Corps bases, several supporting establishments, and in-theater locations around the world. In September 2003, when the ORD was written, the CDD requirements had not been written. The scope was defined at a very high level within the ORD and the material solution had not been selected. Milestones had not been defined, only an IOC and FOC had been determined as shown in Figure 19. In order to meet an IOC in the fourth quarter of FY2004, much work had to be done from development of requirements and architecture, to build and test, to train and field. That is much to accomplish in only a one year period from ORD requirements to a users hands-on-keyboard.

	ORD SCHEDULE (Sep 2003)																											
	FY2004				FY2005				FY2006				FY2007				FY2008				FY2009				FY2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Milestones																												
Reviews																												
Operational Capability				IOC								FOC																
	Date of Schedule					Actual Event Date				No Change from Previous Schedule					Change from Previous Schedule													

Figure 19. GCSS-MC ORD Schedule

The 2004 Acquisition Strategy/Acquisition Plan (AS/AP) defined a program strategy to first select a COTS vendor and then acquire a systems integrator [42]. The program office chose the Oracle 11i E-Business Suite as its COTS material solution and

selected a systems integrator. A fit-gap analysis was performed to see how well the Oracle software satisfied the documented program requirements.

The program office defined milestone events along with a Design Readiness Review (DRR) and Full Rate Production (FRP) review. Figure 20 shows that IOC was delayed two years and FOC was delayed one quarter. It is remarkable that the program thought it could achieve FOC only three to six months after IOC considering fielding is to be to approximately 35,000 users [31]. Note that there is only one year between the MS A and MS B events. That means requirements must be established, contracts put in place, fit/gap analysis performed, architecture developed, system designed built and tested, and users trained and fielded to all within one year. That is very aggressive.

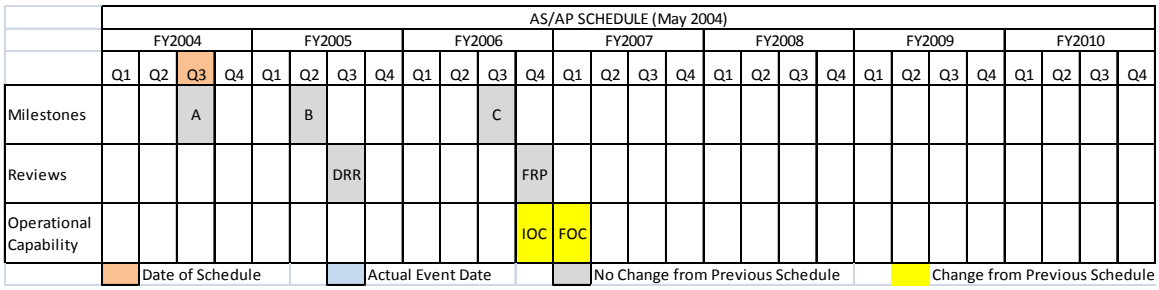

Figure 20. GCSS-MC 2004 AS/AP Schedule

2. Milestone A Achieved

The GCSS-MC program achieved MS A in July 2004. With the Oracle 11i E-Business suite selected as the material solution, a systems integrator selected, and program requirements defined in a CDD, a fit/gap analysis was performed. The program schedule shown in Figure 21 depicts a one quarter delay in the MS B decision but all other dates holding true to the previous AS/AP schedule. Overall, not much of a delay considering the program had advanced one full year. Still ambitious to think FOC follows IOC by only three to six months.

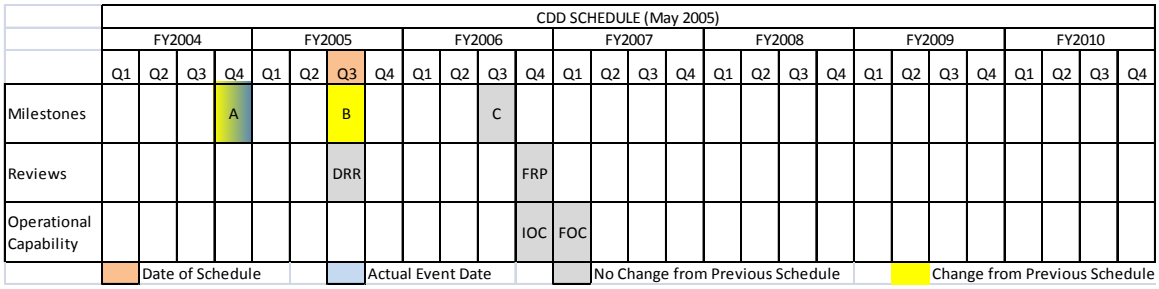

Figure 21. GCSS-MC CDD Schedule

In January 2006, the GCSS-MC program terminated the contract it had with its systems integrator and in February 2006, the program selected a different company to be the new system integrator to determine the high-level architectural, technological, and configuration requirements to support the functional and information needs of the system [42]. This shift in systems integrators caused a new approach to system design using the new system integrators software development methodology. A fit/gap Analysis, RICE object list, and a Conceptual Architecture were developed and technical challenges arose [42]. A combination of switching to a new systems integrator and the discovery of the technical challenges caused delays in the program and a new schedule was developed and reflected in the November 2006 AS/AP shown in Figure 22. MS B, MS C, and IOC were delayed by about two years and FOC was delayed by about two and a half years. Note that more time was inserted between IOC and FOC, about nine months, but even that added time would prove to be a bad estimate as shown later in this thesis.

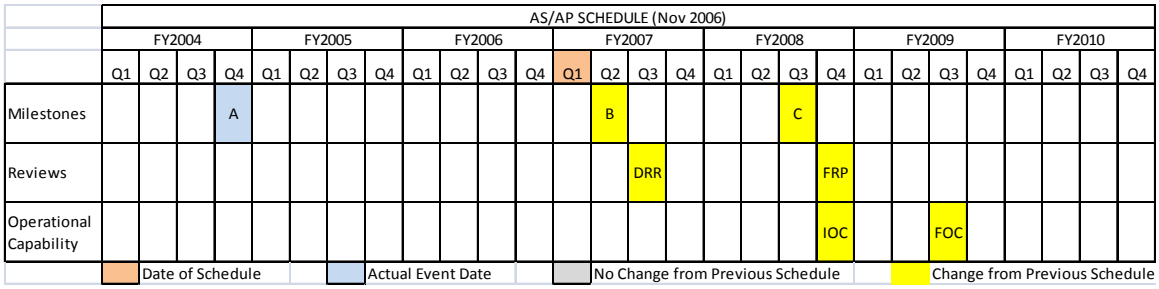

Figure 22. GCSS-MC November 2006 AS/AP

The March 2007 System Engineering Plan did not refer to milestones or IOC/FOC dates so the indication is that they remained the same as the dates in the 2006 AS/AP. Figure 23 shows no delays since the AS/AP schedule from five months back.

	SEP SCHEDULE (Mar 2007)																											
	FY2004				FY2005				FY2006				FY2007				FY2008				FY2009				FY2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Milestones				A										B					C									
Reviews															DRR					FRP								
Operational Capability																				IOC			FOC					
	Date of Schedule						Actual Event Date						No Change from Previous Schedule						Change from Previous Schedule									

Figure 23. GCSS-MC 2007 System Engineering Plan

3. Milestone B Achieved

MS B was achieved in April 2007 only one month after the expected date stated in the AS/AP. The schedule was revised at MS B, MS C and FOC were delayed by about six months and IOC by three months. However the program was still on track to achieve IOC within five years of MS A. Objective and Threshold values were introduced for the first time in the APB, objective dates are shown in Figure 24.

	APB SCHEDULE (Jun 2007) Objective Dates Shown																											
	FY2004				FY2005				FY2006				FY2007				FY2008				FY2009				FY2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Milestones				A											B						C							
Reviews															DRR							FRP						
Operational Capability																					IOC				FOC			
	Date of Schedule						Actual Event Date						No Change from Previous Schedule						Change from Previous Schedule									

Figure 24. GCSS-MC MS B APB Schedule

The GCSS-MC program is an ACAT 1 program required to submit Major Acquisition Information System (MAIS) Quarterly Reports (MQR). In the September 2008 MQR, the GCSS-MC program reported it was likely to breach in the areas of cost and schedule and would fail to achieve IOC within five years of MS A [43]. A Critical Change Team (CCT) was formed to evaluate the program on cost, schedule, and technical performance. The CCT determined that the program would breach cost and

schedule and recommended that the program rebaseline and revise its acquisition strategy to include a two phase implementation approach. The Block 1 program would be split into two releases. Release 1.1 would provide the enterprise functional baseline and allow users to access the system from anywhere in the world as long as they had a high speed internet connection. Release 1.2 would provide access to users who were deployed in an austere, poor communication environment. Figure 25 shows the proposed rebaseline schedule compared to the MS B baseline schedule.

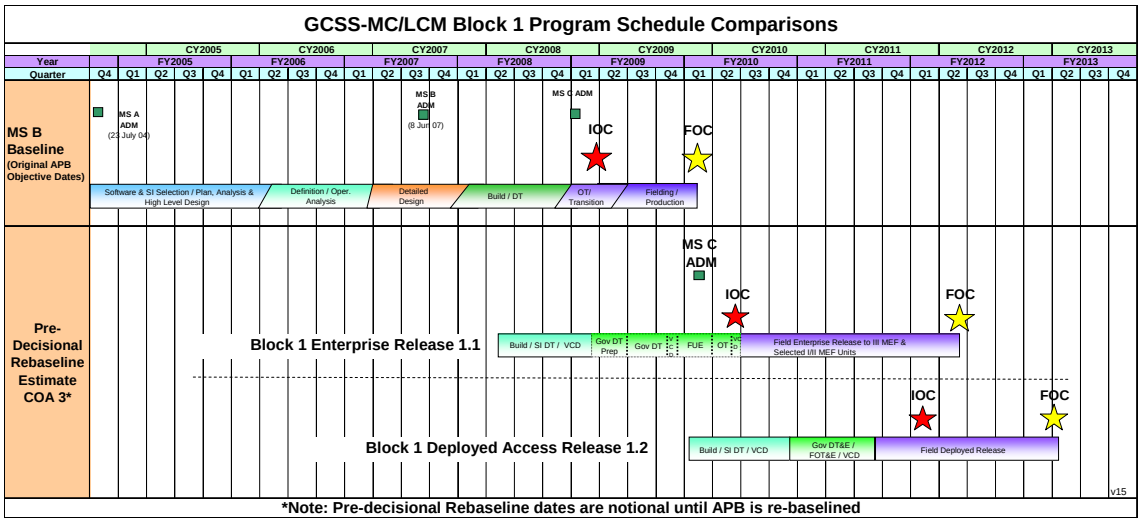

Figure 25. GCSS-MC CCT Schedule Comparisons. From [43]

The CCT recommendation drastically changed the acquisition strategy of the program. The new schedule allowed the program to defer the harder, technically challenging aspects of the program (data synchronization and cross domain solution) to a later release while providing the baseline functional capability of the system sooner to the user. With the accepted new CCT schedule shown in Figure 26, the GCSS-MC program was on a path to achieve a new MS C date in first quarter FY2010.

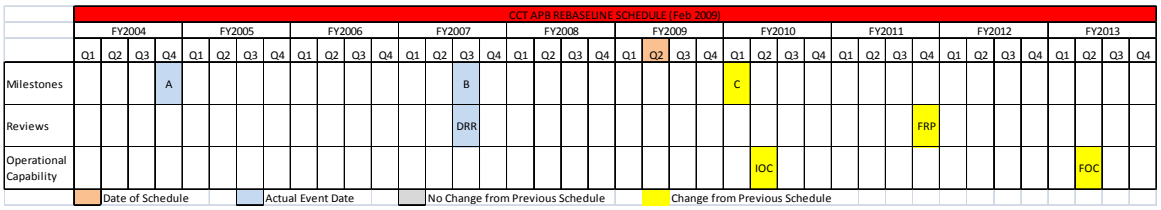

Figure 26. GCSS-MC CCT Rebaseline Schedule

Preparations for MS C were now ongoing in accordance with the new CCT schedule. Even with the revised schedule, the program office realized that MS C would not be achievable as planned in first quarter FY2010. The November 2009 System Engineering Plan being prepared for MS C depicted a modified schedule, shown in Figure 27, that delayed both MS C and IOC by six months still within the six month threshold values.

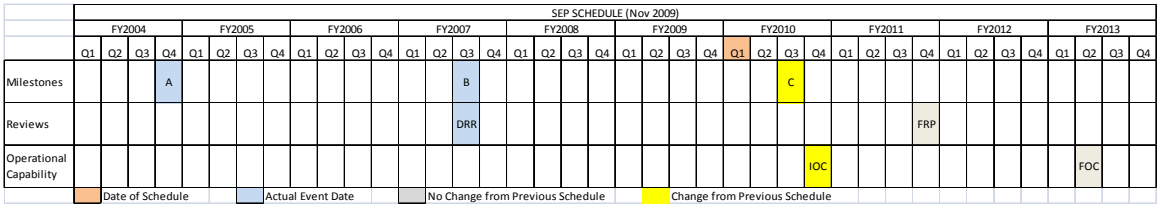

Figure 27. GCSS-MC MS C System Engineering Plan Schedule

The February 2010 AS/AP prepared for the MS C event kept most of the dates stable. The FRP was renamed to Full Deployment Decision (FDD) and was delayed by six months. The FOC was renamed to Full Deployment (FD). The dates in Figure 28 show that the program is now stabilizing and preparing to go into a Functional User Evaluation in second quarter of 2010.

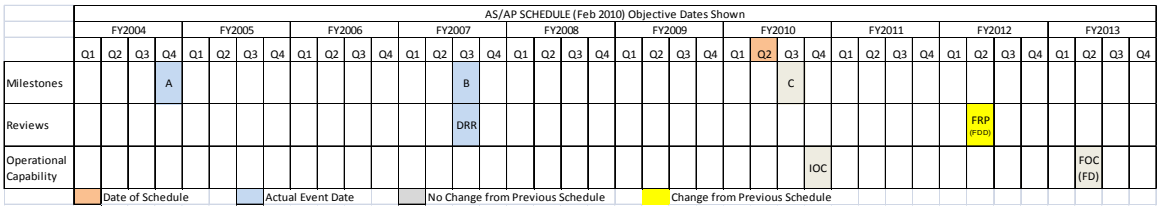

Figure 28. GCSS-MC MS C AS/AP Schedule

The April 2010 APB prepared for the MS C event is shown in Figure 29. IOC was deleted; however Release 1 of GCSS-MC was initially fielded to the Marines in III MEF during the Field User Evaluation (FUE) event and could be considered an IOC for all intents and purposes. All other dates have stabilized and the GCSS-MC program office is on track to fully field the Block 1 capability to the Marine Corps in second quarter FY2013.

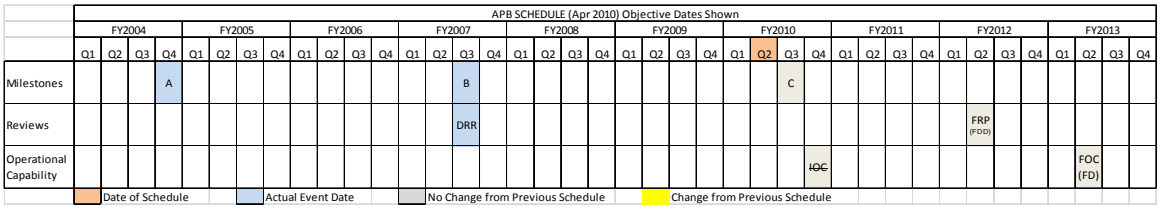

Figure 29. GCSS-MC MS C APB Schedule

The IOC and FOC dates in the 2003 ORD were very ambitious and it was unrealistic to believe that IOC could be achieved in 2004 and FOC could be achieved in 2006. It was not until second quarter 2010 that users could access the system and it will not be until second quarter 2013 that GCSS-MC will be fielded to the entire Marine Corps, about six and a half years after the original dates specified in the ORD.

G. CHAPTER SUMMARY

The GCSS-MC Analysis of Alternatives analyzed five alternative solutions of Status Quo, Upgrade Legacy, Custom Implementation, COTS, and Outsource. The Program Office chose a COTS solution as it met the most intended scope of the system and had the highest return on investment [33].

Requirements have been stable in the GCSS-MC program and a traceability effort has ensured that all requirements are traceable and are being met. The GCSS-MC functional and technical requirements are very unique and extensive customization of the COTS software is required. Only 83% of the programs requirements can be met by the COTS ERP software out-of-the-box. Customization of the ERP software using RICE objects is critical to meeting all of its functional and technical requirements. The development of the RICE objects has introduced a complexity that has caused the program to overrun the budget and delay the schedule. The Program Office has recognized that the complexity in the program lies in the technical challenges and has separated the development effort into two releases. This strategy allows the basic functionality to be delivered to the user sooner than the more technically challenging multi-instance capability.

When the GCSS-MC program chose a COTS product as their material solution to modernize the Marine Corps logistics IT systems [33], the belief was that a product used widely in industry could easily be adapted to suit the business practices of the United States Marines. Throughout the development of GCSS-MC, every time a new schedule would appear in either a systems engineering or acquisition document, the dates for key acquisition events would move to the right. Granted, there was an unexpected change in the system integrator, and that by its very nature can cause a schedule delay, but the technical challenges were not anticipated and feasible schedules could not be developed.

In retrospect, the original IOC and FOC dates in the 2003 ORD were very ambitious. It was not until second quarter 2010 that users could access the system and it will not be until second quarter 2013 that GCSS-MC will be fielded to the entire Marine Corps, about six and a half years after the original dates specified in the ORD.

IV. RESEARCH ANALYSIS

A. INTRODUCTION

The development and implementation of DoD Service Component ERP logistics IT systems has a history of cost overruns and schedule delays. All are trying to modernize their logistics IT systems. How do the ERP implementations of the four Services compare? Are they trying to implement the same functionality? Are they all facing the same challenges? If so, why should the DoD spend as much money as they have in six systems when one system could be developed to be used by all four Services?

In the case of the GCSS-MC program, there were technical challenges to overcome. A detailed look at the GCSS-MC program reveals a level of complexity that was unexpected and not factored into the development effort. What lessons are learned and how can those lessons apply to future ERP developments?

B. SERVICE COMPONENT FUNCTIONAL ANALYSIS

Each Service Component has designed their ERP system to provide logistics chain management to modernize their logistics IT systems. The DoD has adopted a methodology called the Supply Chain Operations Reference (SCOR) model to help describe the business activities associated with all phases of satisfying a customer's demand [44]. SCOR was first investigated by the Navy as part of a supply-chain management project in 1997–'98 [44]. All four Services have applied the SCOR model in some way. The Marine Corps has used it as a guide to help consolidate its information systems, the Navy has used it to help benchmark its process performance, the Army has studied its best commercial practices, and the Air Force has incorporated some of its metrics in its organizational scorecard effort [44]. The DoD's use of the SCOR model may explain why there is so much commonality between the Service ERP efforts.

The SCOR model uses the high level functions of Plan, Source, Make, Deliver, and Return [44]. The SCOR definition of these functions were very generic but could be

mapped loosely to the ERP functionality of the Service Components. Figure 30 shows the functional hierarchy of the ERP functions as they pertain to the SCOR high-level functions.

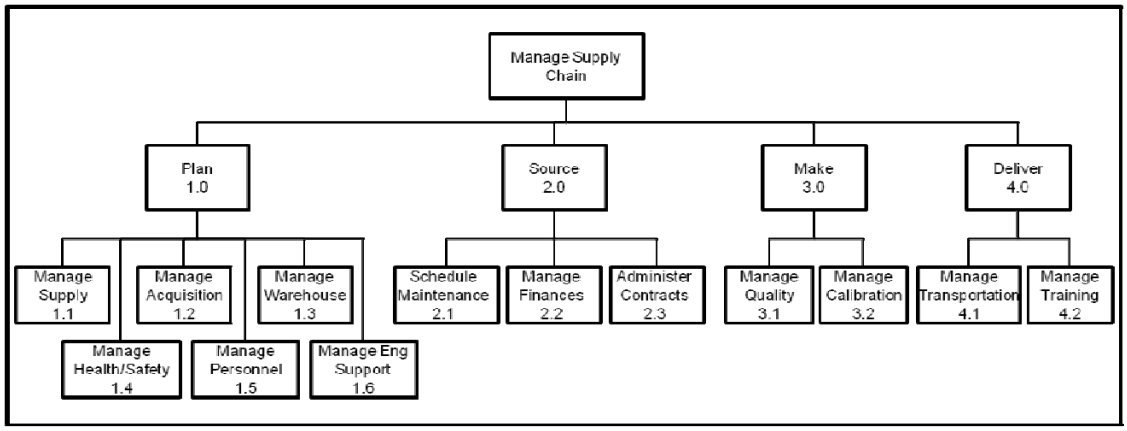

Figure 30. Functional Hierarchy

An analysis of the functional needs of each Service shows that in 10 out of 13 categories, functionality is common in two or more of the Services and in about half of the categories functionality is common in about half of them. This implies that the Service Components have been developing redundant capability and have been spending billions of dollars to solve the same problems. Service Component functions are broken out by category in Table 12 and a comparison of those functions show that a commonality exists across many of the development efforts.

Table 12 Service Component Functional Comparison

Top Level Function	#	Category	Army	Navy	Air Force	Marine Corps
Plan	1	Manage Supply	Supply Support Activity Unit Level Supply Order fulfillment Demand and supply planning Ammunition	Wholesale and retail supply Supply forecasting and demand processing Order fulfillment Demand planning	Supply	Retail and wholesale supply
	2	Manage Acquisition		Acquisition Events management	Acquisition	Acquisition
	3	Manage Warehouse	Asset management Property book	Warehouse management Inventory management		Warehousing
	4	Manage Health and Safety Records	Environmental health and safety			Health
	5	Manage Personnel		Personnel administration		Manpower systems
	6	Manage Engineering Support			Engineering	Engineering
Source	7	Schedule Maintenance	Materiel maintenance Aviation and Ground Maintenance	Intermediate-Level maintenance Maintenance management	Maintenance and repair	Maintenance
	8	Manage Finances	Financial management Finance support to tactical supply and maintenance Cost management	Financials Billing Budgeting Costing and Cost planning Budget exhibits	Financial management Accounting	Financial management

Top Level Function	#	Category	Army	Navy	Air Force	Marine Corps
	9	Administer Contracts	Procurement	Contract awards	Procurement	
Make	10	Manage Quality		Quality management		
	11	Manage Calibration		Calibration management		
Deliver	12	Manage Transportation			Transportation	Transportation
	13	Manage Training		Training		

With so much commonality between the ERP development efforts, a case can be argued that the DoD should pursue only one ERP solution that can be used by all Service Components.

C. SERVICE COMPONENT ERP DEVELOPMENT ANALYSIS

All DoD ERP development efforts addressed in this thesis are trying to modernize their logistics chain management IT infrastructure. All are going through the same basic System Engineering process steps of conceptual design, preliminary design, detail design and development, production/construction, and operational use and system support [45]. All have experienced the same challenges as they try to implement similar capability and functionality.

The modernization of logistics IT systems is a necessity as some of the legacy systems are approaching being in service close to 40 years. Many of the programming languages have been in use for many years, some for decades, and require very senior software engineers to maintain them. Most if not all of these systems were built in a stove-piped fashion with no common interfaces making it difficult to track the authoritative data source for items and necessary to keep the same information in multiple systems. All four Service Components have the need to modernize their logistics IT infrastructure yet all are independently tackling the job.

There are many ways to develop a new logistics IT infrastructure. New programs can be written with current modern day programming languages. There are many programs that specialize in one aspect of logistics management. All four Service Components did not go either of these routes; instead they all chose an ERP COTS solution. This decision allows one suite of software to be used for not only specialized logistics functions, but allows management of the entire logistics chain. This provides cross functionality between the ERP modules and reduces the need for development of additional stove-pipe systems. All four Service Components chose a separate ERP solution and decided to implement their system independent from one another.

Implementation of an ERP in its entirety is a very large undertaking. All Service Components scoped the size of the ERP development effort into smaller increments. This incremental methodology allows a much more manageable effort with opportunities to add on to the baseline system at a later date. Not all of the Service Components started with the same functionality in their initial baseline, however. If a narrow enough scope is defined, it may be possible to focus development on that capability for use by all four Service Components.

The use of ERP COTS software allows the user to begin development with any particular functionality inherent in the complete software suite. All are providing, or planning to provide, much of the same functionality such as ordering a part, scheduling maintenance, tracking assets, tracking finances, planning and tracking distribution, and planning cost. While each Service Component may have started their development efforts with different initial capabilities in mind, ultimately the intent is to focus on complete logistics chain management, a common capability that each Service Component needs.

The intent of each Service Component is to replace their existing logistics IT systems with a modernized state of the art logistics chain management IT infrastructure. This entails the movement of information from the legacy IT system to the ERP system. Legacy data must be cleaned, reformatted, and moved in a consistent manner from each of the legacy systems. This allows the ERP system to view legacy data and maintain a history of information regarding logistics transactions from the past. Each Service

Component has to move legacy data to the new ERP system. This is a very consistent, rigorous, and repeatable operation that can be reused over and over again, not just by one of the Service Components, but shared by all to ensure a consistent transfer of data.

Once the ERP system has been developed it must be fielded to the user. All Service Components have many users in several geographic locations. All require users to be "moved" from using the legacy system to using the new ERP system. This requires extensive training of not only the new ERP system but the understanding of how to perform legacy processes within the new ERP system. Once again, this is a very consistent, rigorous, and repeatable operation that can be reused and shared by all Service Components to ensure that all users get trained in a uniform and consistent manner.

Summarized in Table 13, there are many commonalities between all of the ERP development efforts. It can be argued that this commonality presents a case for the DoD to pursue only one ERP solution that can be used by all Service Components.

Table 13. Service Component Commonality

Common Item	Description
Modernization of Logistics IT	- Replace very old logistics IT systems. - Unsupportable legacy systems. - Stove-piped legacy systems, data not easily transferred.
Using ERP Concepts	- Cross functionality between logistics management functions.
Incremental Development	- Multiple releases. - Reduce scope to a manageable level.

Common Item	Description
Functionality	- Ordering a part. - Scheduling maintenance. - Tracking assets. - Tracking finances. - Planning and tracking distribution. - Planning cost.
Legacy Data Conversion	- Data movement from legacy to ERP system.
Legacy System Cutover	- "Move" users from using the legacy system. - User ERP training. - User process training.

D. GCSS-MC IMPLEMENTATION ANALYSIS

The GCSS-MC ERP development effort has had many challenges since its inception in 2003. Review of other DoD services ERP development efforts within the Air Force, Army, and Navy show that the schedule delays encountered by the GCSS-MC program are "normal." The GAO has written several reports, many referenced in this thesis, regarding the challenges encountered in ERP developments within DoD and there are many factors involved ranging from unrealistic schedule planning to unexpected design complexity of the ERP system.

As the GCSS-MC program progressed through development, more and more information was learned regarding the time required to design, build, and test the system. At each major milestone or critical stage of the GCSS-MC program the schedule was modified. Figure 31 shows that IOC was delayed 6.5 years and FOC was delayed 6 years from the original GCSS-MC ORD estimate. The delays were enough to cause the program to breach schedule and fail to reach MS C five years after achievement of MS A.

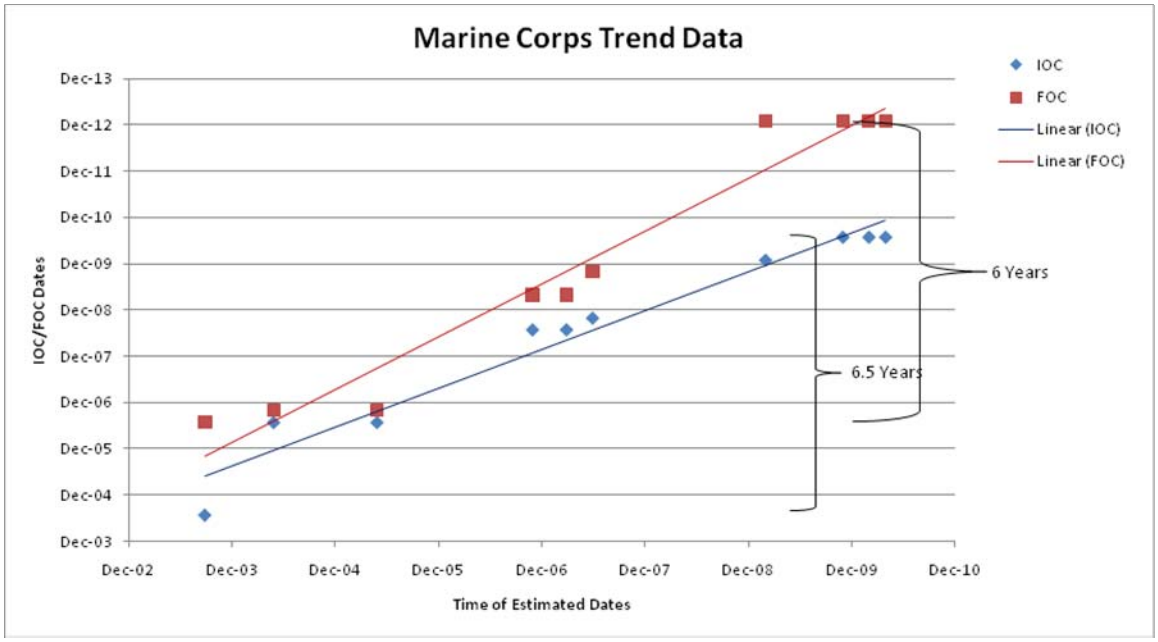

Figure 31. Marine Corps Schedule Trend

The GCSS-MC program's acquisition approach was modified several times due to systems integrator issues and program complexity. While the core requirements remained stable throughout development, the overhead of implementing financial requirements increased the complexity of the effort. The implementation of the core requirements required a logical split between functional availability to the enterprise users and accessibility to the deployed users. It was the complexity of the RICE objects, in particular the RICE objects for data synchronization and SIPRNET, that created a delay in schedule, drove an increase in cost, redefined the scope size of the effort and influenced the program to adopt a two release strategy for the first block of GCSS-MC capability. This two release strategy reinforced the philosophy that designing and implementing smaller increments of capability over short periods of time allows capability, even if it is reduced from the original plan, to be fielded earlier to the user. The GCSS-MC Program challenges are summarized in Table 14.

Table 14. GCSS-MC Program Challenges

Challenge	Description
RICE Objects	- Data conversion and interface complexity.
Schedule	- Delays due to unexpected complexity.
Cost	- Increase cost due to schedule delays.
Scope Size	- Scope split into smaller increments due to schedule delays.
Requirements Definition	- Additional requirements due to unexpected financial requirements.

E. CHAPTER SUMMARY

There are many commonalities between the four Service Components ERP development efforts. All have chosen an ERP solution to modernize their logistics IT systems. All have very similar functionality being developed and implemented in multiple, reduced scope releases. All have to convert data from legacy systems and all have to train users on how to use the new ERP, as well as the corresponding business processes.

All four Services have experienced many similar challenges that have caused cost overruns and schedule delays for all the programs. These overruns and delays are due to program complexity in the areas of data conversion and interface development along with unexpected requirements that are required within the financial community. The question becomes why should the DoD spend as much money as they have in six systems when maybe one system could be developed to be used by all four Services?

THIS PAGE INTENTIONALLY LEFT BLANK

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This research focused on DoD ERP implementation efforts ongoing in the Army, Navy, Air Force, and Marine Corps. A macro-level review of six DoD ERP implementations provided a historical perspective reflecting the difficulty all have had in developing their respective ERP systems. A micro-level review of the GCSS-MC program identified systems engineering challenges the program has faced. The conclusion is that all Service Components have similar requirements and all struggle with development of their respective ERP solution. Much money has been and continues to be spent on ERP implementation. Each implementation has taken much more time than was originally planned. It is important for the DoD to take a hard look at how the current ERP solutions have been developed and determine alternative ways to develop similar systems in the future. The DoD cannot afford the billions of dollars that have been spent on multiple system developments and needs to figure out a way to consolidate efforts between the Service Components. These consolidated efforts may provide not only an expedited system development effort but also a common system that can be centrally managed and used to breakdown the unique stove pipe processes within each Service and transform logistics chain management as it is know today.

Table 15 provides a summary of the recommended ERP implementation methodology activities.

Table 15. ERP Implementation Recommendation Summary

Effort	Actual (Today)	Recommended
DoD ERP Implementation	- Separately managed efforts by four Service Components.	- Single centrally managed effort.
Build and Design	- Individual System Integrator contracts. - Multiple System Integrators and implementation methodologies.	- Multiple System Integrator contracts. - Single System Integrator and implementation methodologies.
RICE Objects	- Severe customization.	- Conform to core software functionality and change business processes of each Service.
Test	- Decentralized.	- No change.
Fielding	- Decentralized. - Unique cutover processes. - Unique training processes.	- Centralized cutover processes. - Centralized training processes.
PDSS	- Decentralized. - Multiple PDSS contracts. - Multiple configurations. - Multiple release management efforts.	- Centralized. - Single Contract. - Single configuration. - Single release management process.

Each Service Component of the DoD is essentially trying to accomplish the same thing by modernizing aging logistics IT systems and streamlining multiple systems into one complete, coherent, and accurate logistics chain management system. All have common implementation strategies but each has unique requirements that represent the core business processes of each Service. All have experienced similar program management and systems engineering challenges recognized by the GAO and continue to struggle with development of their ERP systems.

The GAO determined there were many weak areas in each of the DoD ERP efforts such as:

- Unsuccessful implementation of Enterprise Architectures and CONOPS,
- Lack of MNS in early pilot programs,
- Lack of IV&V implementation,
- Technical challenges in implementation of system interfaces and data conversion from legacy systems,
- Requirements documentation not clearly linked together or aligned to DoD's Enterprise Transition Plan,
- Weak management of earned value and risk.

Many of the GAO identified weak areas impact each Service's ability to accurately determine the time it will take to design, build, test, and field their respective ERP system. An example is GCSS-MC's history of continuing to revise the development schedule at almost every major acquisition milestone and new release of system engineering documentation. The government inherently has a lack of knowledge of how ERP systems work and does not understand well enough the functional gaps between the COTS software and the Service Components requirements. In addition, there are potential scope size challenges that may require development efforts be broken down into smaller manageable pieces in order to decrease the complexity of the effort. The GCSS-MC program recognized the complexity and technical challenges in customizing the COTS product and moved the RICE objects for the cross domain solution and data

synchronization capability into Release 1.2 allowing the GCSS-MC program to field the basic capability of supply and maintenance management sooner to the war fighter and speed up the process of eliminating the legacy supply and maintenance systems.

The application of a COTS product in a DoD environment is much different from that in the private sector. COTS products do not provide unique DoD or Service Component functional and technical capabilities to support things such as mobility of troops and poor communication networks in austere environments. This is much different than stationary brick and mortar buildings with solid and stable communication links. Therefore, the perception of buying a COTS product to minimize development effort is exactly that, a perception. In addition to not supporting the functional and technical requirements, the COTS product does not provide the unique Service Component business processes nor does it provide the unique DoD SFIS and JFMIP financial requirements. The implementation of the unique DoD requirements translates to a large development effort in terms of customization and configuration.

All Service Component ERP development efforts discussed in this thesis are similar in nature and are trying to accomplish the same end goals. The functional analysis shows that the Service Component's are developing redundant capability. The GAO has identified several weaknesses in each independent ERP development. The technical challenges that GCSS-MC has faced are common across the DoD. Would it make sense to develop only one system for use by all of the Service Components that would address all of the GAO identified weaknesses and minimize the functional and technical challenges experienced by the DoD?

B. RECOMMENDATIONS

There is a common functional capability desired by all four Services as they all try to achieve the same goal of modernizing their logistics IT systems. All four Services have already determined and chosen the COTS ERP product as their IT solution. The GCSS-MC Program AOA has shown that a COTS ERP product is the desired implementation method since it uses industry best practices and best meets the defined capability of the Marine Corps [33]. A COTS ERP system, by its very nature, provides a

single integrated package of capability that is common to all four Services. With each individual DoD ERP development effort referenced in this thesis demonstrating severe cost overruns and schedule delays, the recommendation is to develop a single ERP system that can be used by all four Service Components.

Developing a single integrated COTS ERP solution for all four Services is consistent with and satisfies much of the intent of the DoD Information Enterprise Strategic Plan, 2010–2012 [46]. The intent of the Strategic Plan is to share information across DoD and with mission partners, in summary this includes: the information itself; the Department's management over the information life cycle; the processes associated with managing information to accomplish the DoD mission and functions; activities related to designing, building, populating, acquiring, managing, operating, protecting and defending the information enterprise; and sharing of related information resources such as personnel, funds, and equipment [46]. Being a shared system used across DoD, a single integrated COTS ERP solution provides everything the Strategic Plan intends and provides the basis for the following recommended implementation methodology.

Development of a single integrated ERP system provides many advantages such as :

- Reduction of the number of logistics IT systems to maintain - saves billions of development and sustainment dollars,
- Asset visibility across Services - locate and provide gear to war fighter faster and more efficiently,
- Shared data in same place - logistics data available to all Services to make better informed Command and Control decisions,
- Common transportation and distribution - reduce number of deliveries and get gear to war fighter quicker,
- Procurement streamlining - shared transactional procurement data to eliminate unnecessary duplication of gear,

- Consistent processes - train all DoD supply personnel on same processes and provide ability for Services to move personnel between Services.

To develop such a system, a Lead Service or external entity could act as the Program Office and manage the entire life cycle support of the system. The ERP COTS solution should be developed using centralized design, build, and sustainment efforts for all of the Services and decentralized test and field efforts within each of the Services. Centralized design and build efforts ensure common requirements are defined and implemented through a common infrastructure and establishes a solid baseline for commonality across the Service Components. Decentralized test and fielding efforts are required to account for the unique networks of each Service as well as the number of geographic locations and number of systems to be subsumed. The ERP development activities of Design, Build, Test, Field, and Sustain are depicted in Figure 32 and discussed in the following sections.

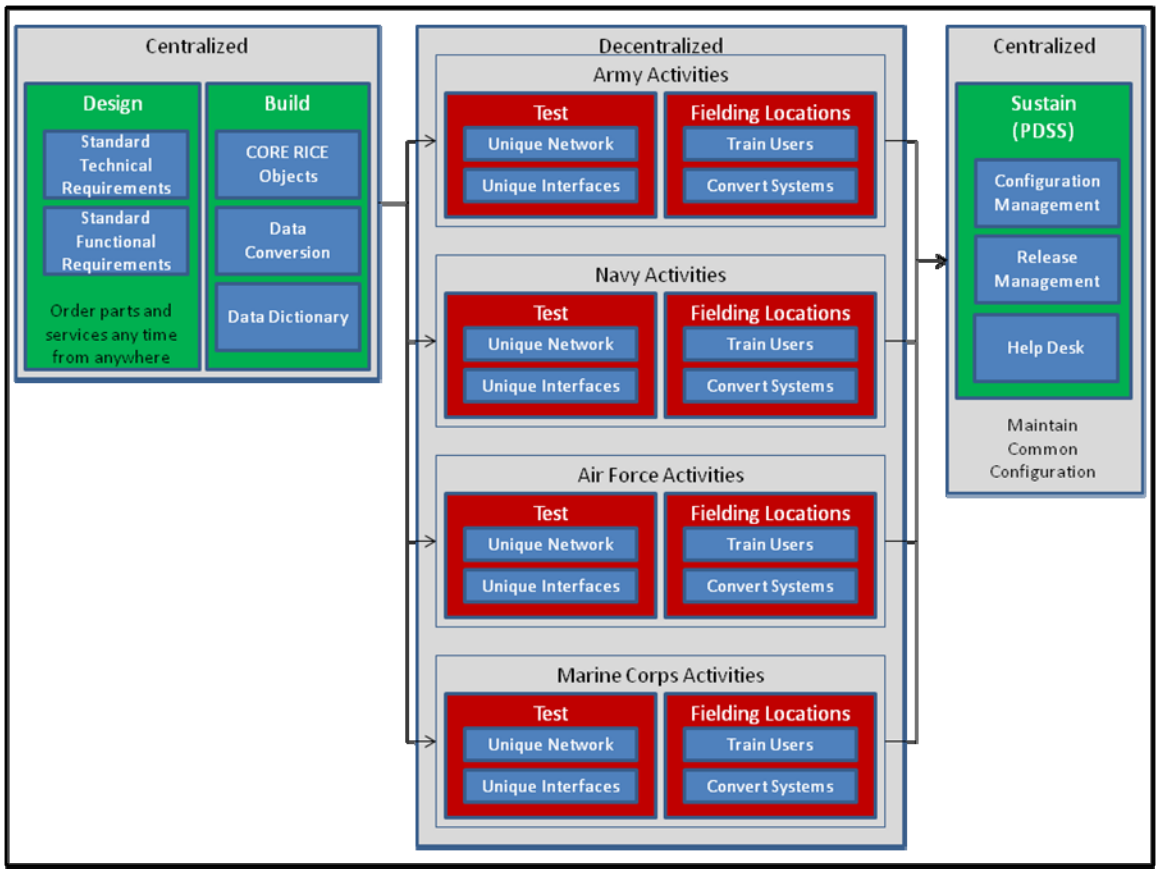

Figure 32. ERP Development Recommendation

1. Centralized Design

The design of the ERP solution needs to address requirements from all four Service Components. Technical requirements should be fairly standard. These include the ability to access the system from any environment with excellent or poor communication networks and the ability to handle a very large number of users. The functional requirements should also be fairly standard, that is, the same business processes to be used by all the Services. Examples are the ability to order a part, schedule maintenance, or track assets. However, this presents a tremendous change management issue for all of the Services since the functional requirements, when standardized, will most likely not resemble the current way business is being done in any of the four Services. The advantage is that a common language for logistics management is established, standard processes are exercised, and all Services conform to one system.

Now consolidated training can be provided to all Services and users from each Service can actually perform the function on behalf of a sister Service in time of need. This means very detailed planning is required up front to ensure the common set of functional requirements address all of the Services functional needs.

2. Centralized Build

The build of the ERP solution will be very data intensive. RICE objects are a big cause for concern because of the complexity they introduce. Any RICE objects that are common across the Services should be incorporated into the core baseline ERP software. To minimize the development of RICE objects, the developer should go to great lengths to use existing functionality already inherent within the ERP COTS software, however, there will be some RICE interface objects required since not all Services connect to the same internal and external systems. There may also be some unique reporting requirements for each Service Component and customized reports may be required to be developed.

There are several other commonalities that can be obtained during the build effort. The use of a common data conversion template allows a rigorous, repeatable, process to convert data from a legacy system. The development of a common data dictionary ensures that all data elements are defined once and used many times by all Service Components in a standardized way.

3. Decentralized Test

Test efforts are decentralized and allocated to the respective Service Component for implementation. This is due to the uniqueness of the network for each Service and accommodates the unique interfaces that each Service must be able to test. This may make it difficult to maintain a single baseline for all four Services since four individual test efforts will be ongoing and may discover problems required to be fixed in the core baseline. This requires an extreme amount of coordination between the Services to manage the configuration of the baseline software.

4. Decentralized Fielding

Fielding efforts are decentralized and allocated to the respective Service Component for implementation. Each Service has a unique number of locations and a unique number of systems to convert and is responsible for implementation of fielding at a local level.

Each location demands not just training users on how to use the new system but training users on how the new system relates to the old system processes. This is part of the change management effort and it is important to convey the relationship between the old and new processes. Local Field Service Representatives will also be available to assist local users on how to use the system when the new ERP system is initiated for the first time.

Each location requires conversion of unique legacy system data into the new ERP system. All data from the legacy system must be cleaned, reformatted, and converted for accuracy and ability to be retrieved from the new system.

Even with Service unique location and legacy system conversion requirements, standardized processes can be still be implemented across the Services. Cutover and training processes can be standardized to be repeatable and with the appropriate data templates, data conversion can also be standardized.

5. Centralized Sustainment, Post-Deployment System Support (PDSS)

After the ERP solution has been designed, built, tested, and fielded, the system will need to be sustained and maintained. Configuration and Release Management become very important as the system is used and patches, enhancements, and modifications are made to the system. A Help Desk is established for user support in times of technical assistance, training, or problem solving in general. Centralization of PDSS means a single contract is needed to maintain support of ERP efforts for all four Services.

The above five activities provide a potential method to develop a single ERP system for logistics chain management in the DoD. At a glance, the recommendation to

develop a single ERP system across Services appears to have merit, however, even a single system development effort will have several challenges that need to be analyzed, socialized, and bought into by the Service Components.

C. AREAS TO CONDUCT FURTHER RESEARCH

This research can be further conducted in a few areas. These areas include:

- ERP System Deployment Options. Analysis can be conducted on how best to deploy an ERP system. This should include not only consideration of the DoD acquisition process but also the methodology used by private industry.
- Single DoD ERP Logistics System Feasibility. This thesis recommended a single system to be centrally managed and developed and used across all four Services, but how feasible is that? Are the individual Services willing to give up their long time used stove piped business processes for a common way to do logistics business across the DoD?
- ERP System Scoping Options. Analysis can be conducted to determine the best approach to "right size" the initial scope for a universally developed DoD ERP logistics chain management implementation. What is the right functionality to be developed for all Service Components to initially start with and how is that functionality determined?

LIST OF REFERENCES

[1] The National Security Archive, “Operation Desert Storm: 10 Years After,” January 17, 2001. [Online]. Available: http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB39/ [Accessed: January 2010].

[2] GLOBALSECURITY.ORG, “Desert Shield / Desert Storm,”. [Online] http://www.globalsecurity.org/military/systems/ship/sealift-ds.htm. [Accessed: May 2010].

[3] Wikipedia contributors, "Iraq War," Wikipedia, The Free Encyclopedia. [Online]. Available: http://en.wikipedia.org/w/index.php?title=Iraq_War&oldid=359341380. [Accessed: May 2, 2010].

[4] Industry Market Trends, “Logistics Lessons from the Military,” June 19, 2003. [Online]. Available: http://news.thomasnet.com/IMT/archives/2003/06/logistics_lesso.html. [Accessed: January 2010].

[5] GLOBALSECURITY.ORG, “Sealift in Operation Iraqi Freedom,”. [Online]. Available: http://www.globalsecurity.org/military/systems/ship/sealift-oif.htm. [Accessed: May 2010].

[6] GLOBALSECURITY.ORG, “Military, US Transportation Command,”. [Online]. Available: http://www.globalsecurity.org/military/agency/dod/transcom.htm. [Accessed: February 2010].

[7] POM-06 Program Working Group. [Online]. Available: https://logmod.hqmc.usmc.mil/library/briefs/GCSS-MC_PWG_Brief.ppt. [Accessed: December 2009].

[8] Wikipedia, “COBOL,”. [Online]. Available: http://en.wikipedia.org/wiki/COBOL. [Accessed: January 2010].

[9] Defense Technical Information Center, “Global Combat Supply Support - Marine Corps EWS Contemporary Issue Paper Submitted by Captain H. H. Williams to Major D. R. Wright, CG 5,” December 2005. [Online]. Available: http://www.dtic.mil/cgibin/GetTRDoc?AD=ADA498337&Location=U2&doc=GetTRDoc.pdf. [Accessed January 2010].

[10] CAPABILITY DEVELOPMENT DOCUMENT FOR GLOBAL COMBAT SUPPORT SYSTEM - MARINE CORPS LOGISTICS CHAIN MANAGEMENT (GCSS-MC/LCM), 25 May 2005.

[11] Cost Analysis Requirements Description (CARD), Global Combat Support System – Marine Corps/Logistics Chain Management (GCSS-MC/LCM) Block 1, Prepared for Milestone C Decision Version 1.5, 15 October 2009, Final.

[12] Proceedings of the 33rd Hawaii International Conference on System Sciences - 2000, "A Taxonomy of ERP Implementation Approaches," A. N. Parr, Dr. G. Shanks.

[13] CAPABILITY DEVELOPMENT DOCUMENT FOR GLOBAL COMBAT SUPPORT SYSTEM – MARINE CORPS / LOGISTICS CHAIN MANAGEMENT (GCSS-MC/LCM) BLOCK 1 VERSION: 1.00, May 2005.

[14] Oracle, Oracle Press Release, "U.S. Marine Corps Selects Oracle(r) to Enable a More Effective Force, Oracle Applications to Support Global Logistics Chain Management,". [Online]. Available: http://www.oracle.com/corporate/press/2004_oct/marine_corps.html. [Accessed: May 2010].

[15] GAO-08-822, DOD BUSINESS SYSTEMS MODERNIZATION, Key Marine Corps System Acquisition Needs to Be Better Justified, Defined, and Managed, July 2008.

[16] GAO-07-860, DOD BUSINESS TRANSFORMATION, Lack of an Integrated Strategy Puts the Army's Asset Visibility System Investments at Risk, July 2007.

[17] GAO-08-866, DOD BUSINESS TRANSFORMATION, Air Force's Current Approach Increases Risk That Asset Visibility Goals and Transformation Priorities Will Not Be Achieved, August 2008.

[18] GAO-05-858, DOD BUSINESS SYSTEMS MODERNIZATION, Navy ERP Adherence to Best Business Practices Critical to Avoid Past Failures, September 2005.

[19] GAO-05-15, DEFENSE INVENTORY, Improvements Needed in DOD's Implementation of Its Long-Term Strategy for Total Asset Visibility of Its Inventory, December 2004.

[20] U.S. ARMY, "GCSS-Army FAQs,". [Online]. Available: https://www.gcss-army.lee.army.mil/FAQs.html. [Accessed: February 2010].

[21] Government Computer News, "ERP Task Force," Jeff Erlichman. [Online]. Available: http://gcn.com/microsites/2009-peo-eis-guidebook/erp-task-force.aspx. [Accessed: January 2010].

[22] GAO-03-458, DOD BUSINESS SYSTEMS MODERNIZATION, Improvements to Enterprise Architecture Development and Implementation Efforts Needed, February 2003.

[23] GAO-06-831, ENTERPRISE ARCHITECTURE, Leadership Remains Key to Establishing and Leveraging Architectures for Organizational Transformation, August 2006.

[24] U.S. ARMY PEO EIS, “Project Manager Logistics Modernization Program (LMP),”. [Online]. Available: http://www.eis.army.mil/programs/lmp.htm. [Accessed: February 2010].

[25] A Critical Success Factors Model For ERP Implementation, IEEE Software May/ June 1999, Christopher P. Holland and Ben Light, Manchester Business School.

[26] BOTTOMline, “Navy ERP and Logistics Systems,” Naval Supply Systems Command, December 2009. [Online]. Available: https://www.navsup.navy.mil/navsup/news/the_bottom_line/7AF12A1A703127EBE04400144F2D8694. [Accessed: January 2010].

[27] ASSISTANT SECRETARY OF DEFENSE, Memorandum, Designation of Major Automated Information System Programs and Information Technology Services Acquisitions Oversight List, December 26, 2007.

[28] GAO-08-896, DOD BUSINESS SYSTEMS MODERNIZATION, Important Management Controls Being Implemented on Major Navy Program, but Improvements Needed in Key Areas, September 2008.

[29] EXPEDITIONARY COMBAT SUPPORT SYSTEM, “Fact Sheet,”. [Online]. Available: http://www.af.mil/shared/media/document/AFD-060831-042.pdf. [Accessed: February 2010].

[30] U.S. AIR FORCE, “Expeditionary Logistics for the 21st Century,”. [Online]. Available: http://www.af.mil/information/elog21/index.asp. [Accessed: February 2010].

[31] OPERATIONAL REQUIREMENTS DOCUMENT GLOBAL COMBAT SUPPORT SYSTEM-MARINE CORPS (GCSS-MC), 11 September 2003.

[32] Defense Acquisition Management Information Retrieval (DAMIR), “Acquisition Program Baseline (Proposed), GCSS-MC,” 23 April 2010.

[33] ANALYSIS OF ALTERNATIVES (AOA), GLOBAL COMBAT SUPPORT SYSTEM – MARINE CORPS / LOGISTICS CHAIN MANAGEMENT (GCSS-MC/LCM) Block 1, Version 1.3, May 10 2004.

[34] GCSS-MC Program Office, “GCSS-MC/LCM Block 1 Capability Release 1 Requirements Brief,” Global Implementation Division, June 2009.

[35] Federal Financial Management Systems Requirements, Travel System Requirements, JFMIP-SR-99-9, July 1999. [Online]. Available: http://www.jfmip.gov/fsio/download/systemrequirements/Travel_system_requirements.doc. [Accessed: May 2010].

[36] Business Transformation Agency, "Standard Financial Information Structure (SFIS) Resources: The Common Business Language of DoD,". [Online]. Available: http://www.bta.mil/SFIS/SFIS_resources.html. [Accessed: May 2010].

[37] United States Marine Corps, Accounting & Financial Systems [RFA] Vision. [Online]. Available: http://www.usmc.mil/unit/pandr/Pages/rfa.aspx. [Accessed: May 2010].

[38] The *ERP Project Risk Assessment* – A case study. Päivi Iskanius. Proceedings of the World Congress on Engineering 2009 Vol I. WCE 2009, July 1– 3, 2009. [Online]. Available: http://www.iaeng.org/publication/WCE2009/WCE2009_pp752-756.pdf. [Accessed: May 2010].

[39] ERPandMORE.COM, "Having RICE with your ERP Implementation," Chris Shaul. [Online]. Available: http://www.erpandmore.com/2007/02/07/having-rice-with-your-erp-implementation/. [Accessed: April 2010].

[40] GLOBAL COMBAT SUPPORT SYSTEM-MARINE CORPS (GCSS-MC) BLOCK 1 BUSINESS PROCESS RE-ENGINEERING, DC I&L (LPV) Brief, February 25 2010.

[41] Root Cause Analysis for Global Combat Support System – Marine Corps (GCSS-MC) Acquisition Program Baseline Breach, 30 August 2008.

[42] ACQUISITION PLAN (AS/AP), GLOBAL COMBAT SUPPORT SYSTEM – MARINE CORPS / LOGISTICS CHAIN MANAGEMENT (GCSS-MC/LCM) Block 1, Version 1.2, 5 May 2004.

[43] PROGRAM EXECUTIVE OFFICER – ENTERPRISE INFORMATION SYSTEMS (PEO – EIS), GLOBAL COMBAT SUPPORT SYSTEM – MARINE CORPS (GCSS – MC) MAJOR AUTOMATED INFORMATION SYSTEM (MAIS), CRITICAL CHANGE REPORT, 12 December 2008.

[44] InTech, "To SCOR, Practice Makes Perfect", Melinda Spring, 10 August 2001. [Online]. Available: http://www.isa.org/InTechTemplate.cfm?Section=InTech&template=/ContentManagement/ContentDisplay.cfm&ContentID=9437. [Accessed: July 2010].

[45] Pearson/Prentice Hall, "Systems Engineering and Analysis, Fourth Edition," Benjamin S. Blanchard and Wolter J. Fabrycky, Copyright 2006, Pearson Education, Inc.

[46] Department of Defense, “Information Enterprise Strategic Plan”, 2010-2012. [Online]. Available: http://cio-nii.defense.gov/docs/DodIESP-r16.pdf. [Accessed: July 2010].

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California